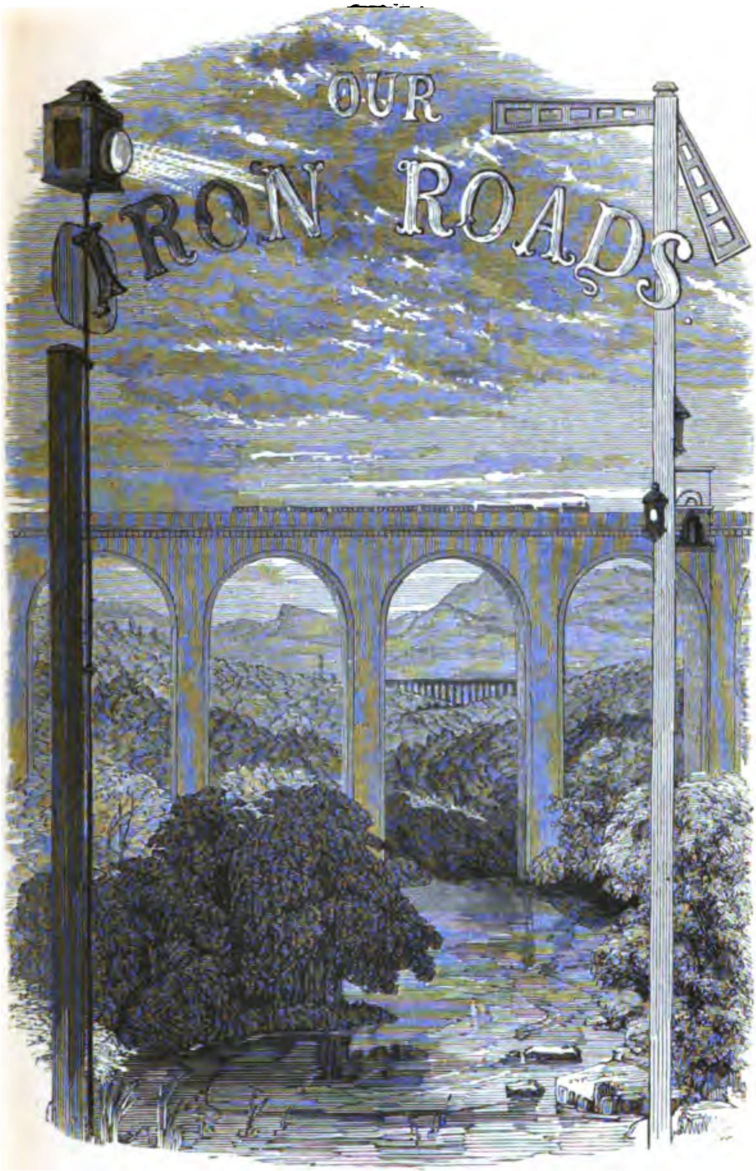

OUR IRON ROADS

SHAKESPEARE'S CLIFF—SOUTH-EASTERN RAILWAY.



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OUR IRON ROADS:

THEIR HISTORY, CONSTRUCTION,

AND

SOCIAL INFLUENCES.

By FREDERICK S. WILLIAMS.

With Numerous Illustrations.

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PREFACE.

It has often been remarked, that it is possible for men to live in habitual contact with the most wonderful and beautiful objects, and yet to be altogether unaffected by their presence. The peasant will dwell beneath the mountain range, whose colossal peaks are covered with eternal snows, without feeling any homage for its grandeur; and multitudes will wander heedlessly upon the shore, unconscious of the sublimity of the ocean. And this principle is true of man's relation to the world of science. We are often as ignorant of its operations as we are familiar with its effects. The blessings which it confers are daily enjoyed, till their amplitude makes us indifferent to the causes and means from which they originate. Such is the case, to a great extent, with that mighty and elaborate locomotive system which has arisen under our own observation, which filled all with admiration, till its wonders were almost too numerous to be appreciated, and yet with the arrangements and operations of which few are acquainted.

With the desire of at once stimulating and satisfying a laudable curiosity in reference to this subject, the present volume has been prepared. In it the author has endeavoured to sketch the rise and progress of the Railway System; to describe the various processes in the erection of the noble and wonderful structures which the formation of our Iron Roads has called into existence; to explain the arrangements which are neces-

sary for their successful management; and to point out those social influences which have arisen from their establishment. He has attempted to gather, from the results of personal observation, from the experience of practical men, and from the ephemeral and fragmentary records of contemporary history, the progress and the effects of railway enterprise, and to embody these in the form of connected narrative; and, while avoiding the tediousness of minute detail, he has striven to portray the bolder features of the past and present condition of the mightiest physical agency which has been discovered in modern times for the promotion of the comfort and welfare of man.

The author cannot omit the expression of his acknowledgments to the Directors, Secretaries, and other Officers of the various Railway Companies, by whom he has been favoured with special facilities of observation, and with important information in reference to the management of their several lines; and also to those Engineers and other gentlemen who have materially assisted him in the preparation of this volume, by the valuable results of their professional experience.

LONDON, *August* 1, 1852.

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OUR IRON ROADS.

CHAPTER I.

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THE means of communication from place to place in our own country were extremely limited till the commencement of the sixteenth century. People did, under special circumstances, manage to go from one part of the island to another; but, as regards the masses, travelling up to that period was rather a matter of theory than of practice. A journey was often, in early times, a very serious affair. The only way of proceeding was on horseback, and the Rozinante was compelled to go on till he was tired, and then both master and horse had to wait and rest. If the horse fell lame, the rider was obliged to tarry till he was sound again; if the steed died, and another could not be obtained, the traveller had to stop, or proceed on foot. But, putting such disasters—common as they were—out of the calculation, the comfort of the rider was dependent on the roads, which were often in a miserable condition. Fatigue, even for the strongest, was inevitable, and danger was often imminent. Instead of the firm footing which the horse now has, he might suddenly plunge into a marsh; or, there being no ford or bridge over a river,

the swollen flood would often prevent a passage, while if this were attempted, both horse and rider might be drowned. Sometimes the road lay through deep woods, where the track was not easily discernible; and instead of the anticipation of the cheerful fire or the well-spread table of an inn to cheer his steps, the pilgrim had occasionally to seek repose on the cold earth, while the winds whistled round him; or to find refuge from the falling rain in some roofless ruin, and having gathered a little warmth from the dying embers of a wretched fire, to sink into welcome slumber on the "cold, cold ground." And it is necessary that we should have vividly before us such retrospects as these, not only in order to have a just idea of the past condition of things, but that we may appreciate the blessings which we now enjoy.

When such were the difficulties of transit, it is not surprising that journeys were usually undertaken only by "the sterner sex," and that if ladies travelled it was necessary that they should be adepts in equestrianism. From the time of the Wife of Bath, "gilt with a pair of spurrés sharp," to the days of Queen Elizabeth, there is scarcely any record of ladies accomplishing their peregrinations in any other way than that to which Chaucer has alluded—

"Upon an ambler easily she sat."

Improvements, however, were gradually effected, but no very decided change for the better could be made at any time, or in any country, so long as roads were in the defective condition in which they remained till a comparatively recent period.

Occasionally we find that a very rapid journey was made, and Sir Robert Carey, who determined to be the first to communicate to James the intelligence that he was king of England, stole out of Richmond Palace at three o'clock on the morning of the 24th of March, 1603, and reached Edinburgh, a distance of four hundred miles, in seventy hours. Yet so slow was the general communication throughout the country, that the news of the death of Elizabeth did not reach York till the 27th.* Though the post was not then established by law, there were post-masters, at the end of the sixteenth century, on all the great lines of roads, and their speed is a good test of the rate of conveyance of the time. Yet the transmission of intelligence over the Atlantic is now easier and far more certain than was the sending a letter at that time for two hundred miles upon cross roads.

The historian of Craven, alluding to the early part of the seventeenth century, tells us that, at that period, the communication

* Continuation of Stow's Annals.

between the north of England and the universities was maintained by carriers, who pursued their tedious but uniform route with trains of pack horses. To their care were consigned not only the packages, but frequently the persons of young scholars. It was through their medium also that epistolary correspondence was conducted; and as they always visited London, a letter could scarcely be exchanged between Yorkshire and Oxford in less than a month.

Having seen the evils which constantly arose from the inefficiency of the existing means of communication, Charles I., in 1635, ordered "a running post or two to run, night and day, between Edinburgh and London, to go thither and come back again in six days," and other towns were promised similar advantages. In 1660, the general post-office was established by Act of Parliament, and all letters were ordered to be transmitted through it, except such "as should be sent by coaches, common known carriers of goods by carts, wagons, and pack-horses, and should be carried along with their carts, wagons, and pack-horses respectively."

The country post-master was generally an inn-keeper; and Taylor, the water-poet, in his "Penniless Pilgrimage" from the metropolis to Scotland, in the early part of the seventeenth century, describes one of these extortionate worthies:—"From Stamford," he says, "we rode to Huntingdon, where we lodged at the post-master's house, at the sign of the Crown; his name is Riggs. He was informed who I was, and wherefore I undertook this my penniless progress; wherefore he came up to our chamber and supped with us, and very bountifully called for three quarts of wine and sugar, and four jugs of beer. He did drink and begin healths like a horse-leech, and swallowed down his cups without feeling, as if he had the dropsy, or nine pounds of sponge in his maw. In a word, as he is a post, he drank post, striving and calling by all means to make the reckoning great, or to make us men of great reckoning. But in his payment he was tired like a jade, leaving the gentleman that was with me to discharge the terrible shot, or else one of my horses must have laid in pawn for his superfluous calling and unmannerly intrusion."

In a pamphlet called "The Grand Concern of England Explained," published in 1673, the writer gravely depicted the miseries, and the ruin of trade, occasioned by the introduction of coaches. The style of reasoning is worthy of notice, for the method of argument; and the political and social principles enunciated in it, still find acceptance among a few in our own day. "Before the coaches were set up," he says, "travellers rode on horseback, and men had boots, spurs, saddles, bridles, saddle-cloths, and good riding suits, coats and cloaks,

stockings and hats, whereby the wool and leather of the kingdom were consumed. Besides, most gentlemen when they travelled on horseback used to ride with swords, belts, pistols, holsters, portmanteaus, and hat-cases, which in these coaches they have little or no occasion for. For when they rode on horseback, they rode in one suit, and carried another to wear when they came to their journey's end, or lag by the way; but in coaches they ride in a silk suit, with an Indian gown, with a sash, silk stockings, and the beaver hats men ride in, and carry no other with them. This is because they escape the wet and dirt which on horseback they cannot avoid; whereas in two or three journeys on horseback, these clothes and hats were wont to be spoiled, which done, they were forced to have new very often, and that increased the consumption of manufacture. If they were women that travelled, they used to have safeguards and hoods, side-saddles and pillions, with strappings, saddle or pillion cloths, which, for the most part, were laced and embroidered; to the making of which there went many several trades, now ruined."

The writer also complained, that those who travelled by the new conveyances became weary and listless when they rode only a few miles; that they were unwilling to get on horseback, and unable to endure frost, snow, or rain, or to lodge in the fields. Besides, he asked, what advantage could it be for a man's health, to be called out of bed into these coaches an hour or two before day in the morning, "to be hurried in them from place to place till one, two, or three hours within night; insomuch that, after sitting all day in the summer time, stifled with heat and choked with dust; or in the winter time, starving or freezing with cold, or choked with filthy fogs—they are often brought into their inns by torch-light, when it is too late to sit up to get supper; and next morning they are forced into the coach so early, that they can get no breakfast? What addition is it to a man's health or business to ride all day with strangers,—oftentimes sick, ancient, diseased persons,—or young children crying; all whose humours he is obliged to put up with, and is often poisoned with their nasty scents, and crippled with boxes and bundles? Is it for a man's health to be laid fast in the foul ways, and forced to wade up to his knees in mire; afterwards sit in the coach till teams of horses can be sent to pull the coach out? Is it for their health to travel in rotten coaches, and to have their tackle, or perch, or axletree broken; and then to wait three or four hours (sometimes half the day), and afterwards travel all night to make up their stage?" He benevolently argued, that only a few coaches should be allowed "to go through with the same horses they set forth with, and not

travel above thirty miles a day in the summer, and twenty-five in the winter, and to shift inns every journey, that so trade might be diffused;" while accommodation would thus be furnished for "the sick and lame, that they pretend cannot travel on horseback." Even these, however, should be suppressed within fifty miles of London, where he affirmed that "they were no way necessary."

The state of the roads in the south of England in 1703 must have been far worse than the imagination can now readily depict. In a journey which was undertaken from Portsmouth to the Duke of Somerset's, at Petworth, in Sussex, fourteen hours were occupied. An attendant thus speaks of the pilgrimage:—"We set out at six o'clock in the morning to go to Petworth, and did not get out of the coaches, save only when we were overturned and stuck fast in the mire, till we arrived at our journey's end. 'Twas hard service for the prince to sit fourteen hours in the coach that day, without eating anything, and passing through the worst ways that I ever saw in my life. We were thrown but once indeed in going; but both our coach, which was leading, and His Highness's body-coach, would have suffered very often, if the nimble boors of Sussex had not frequently poised it, or supported it with their shoulders, from Godalming almost to Petworth; and the nearer we approached the duke's the more inaccessible it seemed to be. The last nine miles of the way cost six hours time to conquer." In the life-time of the "proud Duke of Somerset," who died about the middle of the eighteenth century, the roads in Sussex were so bad, that, in order to arrive at Guildford from Petworth, it was necessary for travellers to make for the nearest point of the great road for Portsmouth to London; and the journey was a work of so much difficulty as to occupy the whole day. The distance between Petworth and London is less than fifty miles; and yet the duke had a house at Guildford which was regularly occupied as a resting-place for the night by any part of his family travelling to the metropolis.* And this was little more than a hundred years ago!

The way in which travelling was carried on in 1740 is illustrated by Pennant.† In March, he tells us, he changed his Welsh school for one nearer to the capital, and travelled in the Chester stage. The first day, with much difficulty, he reached Whitchurch, a distance of twenty miles from Chester; the second day he arrived at the Welsh Harp; the third, at Coventry; the fourth, at Northampton; the fifth, at Dunstable; and, by special effort and perseverance, they reached London before the commencement of the next night. "The

* Archæologia. † Journey from Chester to London.

strain and labour of six good horses, sometimes eight, drew us," he says, "through the sloughs of Mireden, and many other places. We were frequently out two hours before day, and as late at night, and in the depth of winter proportionably later. Families who travelled in their own carriages contracted with Benson and Co., and were dragged up in the same number of days by three sets of able horses. The single gentlemen, then a hardy race, equipped in jack-boots and trowsers up to their middle, rode post through thick and thin; and, guarded against the mire, defied the frequent stumble and fall, arose and pursued their journey with alacrity,—while in these days their enervated posterity sleep away their rapid journeys in easy chaises, fitted for the conveyance of the soft inhabitants of Sybaris."

A hundred years ago there was no regular stage-coach from London to Edinburgh; and the Scottish newspapers occasionally contained advertisements, stating, that an individual about to proceed to the metropolis by a post-chaise, would be glad to hear of a fellow-adventurer or two; that, by mutual assistance, the expense might be diminished to each. Before 1754, however, a stage-coach was established on the route between the two British capitals; and, in the Edinburgh Courant for that year, it was advertized, that "The Edinburgh stage-coach, for the better accommodation of passengers, will be altered to a new genteel two-end glass coach-machine, hung on steel springs, exceeding light and easy, to go in ten days in summer and twelve in winter; to set out the first Tuesday in March, and continue it, from Hosea Eastgate's, the Coach and Horses, in Dean-street, Soho, London; and from John Somerville's, in the Canongate, Edinburgh, every other Tuesday, and meet at Burrowbridge on Saturday night, and set out from thence on Monday morning, and get to London and Edinburgh on Friday. In winter, to set out from London to Edinburgh every other (alternate) Monday morning, and to go to Burrowbridge on Saturday night; and to set out from thence on Monday morning, and get to London and Edinburgh on Saturday night. Passengers to pay as usual. Performed, if God permits, by your dutiful servant Hosea Eastgate."

Arthur Young, who travelled in Lancashire about the year 1770, has left us a forcible and graphic, if not elegant sketch of the state of the roads and of the means of communication. "I know not," he says, "in the whole range of language, terms sufficiently expressive to describe this infernal road. Let me most seriously caution all travellers who may accidentally propose to travel this terrible country, to avoid it as they would the devil; for a thousand to one they break their necks or their limbs by overthrows or breakings down. They

will here meet with ruts, which I actually measured, four feet deep, and floating with mud, only from a wet summer; what, therefore, must it be after a winter? The only mending it receives, is tumbling in some loose stones, which serves no other purpose than jolting a carriage in the most intolerable manner. These are not merely opinions, but facts; for I actually passed three carts broken down in these eighteen miles of execrable memory." Subsequently, in speaking of a turnpike road near Warrington, he says, "This a paved road, most infamously bad. Any person would imagine the people of the country had made it with a view to immediate destruction! for the breadth is only sufficient for one carriage; consequently, it is cut at once into ruts; and you may easily conceive what a break-down, dislocating road, with ruts cut through a pavement, must be." Such was the style of travelling in Britain less than a century ago, from the time we write. Truly may we say, "*tempora mutantur, et nos mutamur in illis.*"

As illustrative of the speed at which locomotion was performed in 1766, Lord Eldon mentions, that, when he left school in that year to go to Oxford, he came up from Newcastle to London in a coach, which was called "a fly," on account of its quick travelling, as it was then thought; but he was three or four days and nights upon the road. There was no such velocity as to endanger overturning or other mischief; as a sort of apology for which there was printed on the panel of the carriage the phrase "*Sat cito, si sat bene.*" The effect of this sentence upon the mind of the embryo chancellor was heightened by a circumstance which occurred upon the journey. A quaker, who was a fellow-traveller, stopped the coach at the inn at Tuxford, desired the chamber-maid to come to the coach-door, and gave her sixpence, telling her, that he forgot to give it her when he slept there two years before. Young Scott, who was not characterized by too great bashfulness of manner, said to him, "Friend, have you seen the motto on this coach?" "No!" "Then look at it; for I think, giving her only sixpence *now* is neither *sat cito* nor *sat bene.*"

Despite the opposition which improvements excited, and we suppose always will excite, facilities of communication throughout the country gradually and steadily increased. The money expended in travelling, was at length sufficient to allow a more regular repair of the roads, and lighter vehicles were substituted for the cumbrous machines that had been employed. The breed of horses, too, was greatly improved; and, at length, England surpassed all other countries in the excellence of its roads, the comfort of its conveyances, and the blood, strength, and speed of its "cattle."

Many are there, who still talk of the delights of travelling in "the coaching days of old." They like to recall to mind the memories of the pleasant summer days they spent on the box-seat, chatting with the burly coachman; who, well protected against the possibilities of the weather by innumerable coats, knew every man and every horse he met, and could tell all the news of the country round.

They describe, in glowing terms, the manner in which the mail was taken each morning or evening in the year to the authorised inspector, who examined every inch from the pole to the hind boot, and who critically probed and tested the wheels, axles, linch-pins, springs, and glasses;—how scrupulously every part was cleaned, and how every horse was groomed with as much precision as if he belonged to the stud of a nobleman. We, perhaps, smile at their enthusiasm, but admit that there is much reason for it, when the scenes thus delineated are connected with many a pleasing association. At eight o'clock, P.M., the coach was in all the "pride and panoply" of authority, with its mettled steeds "on parade" in Lombard-street, waiting to receive its bags; or, perhaps, it was one of those special occasions in which all ordinary circumstances were surpassed. The tidings of a victory had been received,—a national foe had been defeated,—and the mail was about to convey the intelligence to a thousand homes. Instead of the news being quietly spread over the length and breadth of the land in a few seconds, as in our own day, resort was had to more ordinary means. Horses, men, and carriages were accordingly dressed in laurels and flowers, oak-leaves and ribbons. Coachmen and guards displayed the royal livery to the best advantage around their rotund forms; passengers merged the reserve of their individuality in a stronger feeling of national exultation; and when the loud noise of the lids locked down on the mail-bags smote on the ear, the trampling of fiery steeds was heard as they bounded off like leopards, amidst the thundering of wheels, and the boisterous shouts of assembled hosts of observers. In the vivid remembrance of such scenes, it is scarcely surprising that some should regret that they have passed away for ever,—that tidings must now be transmitted by steam, or electric telegraph, and that the voice of the trumpet that once announced from afar the approach of the laurelled mail, should be lost amid the hisses or shrieks of the locomotive. We can almost join with them when they sing:—

> "We miss the cantering team, the winding way,
> The road-side halt, the post-horn's well known air,
> The inns, the gaping towns, and all the landscape fair."

Now and then, indeed, we may meet with "a relic" who utterly

THE WAY-SIDE INN.

despises the present means of locomotion, in contrast with the pecu-
liar advantages which, he affirms, were enjoyed under the coaching

system. He tells us, with a sneer, that now we don't *travel*, but *are transferred* from one part of the country to another; a satire which seems of the same order as that which was embodied in the sentiment of a venerable gentleman, who once bitterly exclaimed to a young acquaintance who had passed through a dental operation, "*Draw* teeth, indeed! They never draw them now-a-days. When I was a boy, they used to draw your teeth, and draw you all round the room, too!"

But while to some, these scenes and circumstances of the past, "though lost to sight," may still be "to memory dear," yet no mind untroubled by some obliquity of perception, will hesitate to rejoice in the substitution of the means of locomotion now employed, attended, as they are, by benefits so numerous and permanent. To a brief account of the circumstances which led to their development, the attention of the reader is invited.

"You must be making handsomely out with your canals," it was once remarked to the celebrated Duke of Bridgewater. "Oh, yes," rejoined his grace, "they will last my time; but I don't like the look of these tram-roads,—there's mischief in them." The observation of the duke was, in a sense, prophetic: those wooden roads were the foreshadowing of the Railway system of the present day. Many conjectures have been offered as to the origin of the term "tram-road," but it appears to have been taken from the name of Mr. Outram, who was early connected with their employment; and they would, doubtless, have been called outram-roads, were it not for the well-known custom practised by Englishmen, of reducing all their words to the most practicable dimensions. The application of the principle on which their value depends, may be traced in the construction of early Italian streets, and especially of those of Milan, where a smooth surface is provided for the passage of wheels, and a rough one on which the horses may tread with security; but the precise date at which they were first used does not appear. It is sufficient to observe that more than two hundred years ago, tram-roads existed in the colliery districts; and Roger North, in describing a visit paid by his brother, Lord Guildford, to Newcastle, remarks, that among the curiosities of the region were the "way-leaves." "When men," he says, "have pieces of ground between the colliery and the river, they sell *leave* to lead coals over the ground, and so dear, that the owner of a rood of ground will expect £20 per annum for this leave. The manner of the carriage is by laying rails of timber from the colliery down to the river, exactly straight and parallel, and bulky carts are made with four rowlets fitting these

rails, whereby the carriage is so easy, that one horse will draw four or five chaldrons of coals, and is of immense benefit to the coal merchants."* The advantage here resulted from the hard, smooth, and unchanging surface on which the wheels passed, and which is the peculiar characteristic of tram-roads, though the material and the way they are made may be varied.

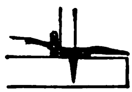
Towards the close of the last century, tram-roads were extensively employed in many parts of this country. The rails forming the tracks for the wagon-wheels were of wood, and about four inches in breadth, supported on pieces of timber called sleepers, to which they were secured by wooden pins. The friction of the wheels of passing vehicles gradually wearing out the rails, new ones were substituted; but it was soon found that the number of pin-holes caused such weakness in the sleepers, that new ones were required. This difficulty was, however, obviated, by the construction of the double timber Railway, which was so contrived, that when the upper rails were worn out, they could easily be replaced. The height to which the surface of the rails was raised, afforded opportunity of protecting the sleepers from the horses' feet, by covering them with gravel, and thus giving them greater permanence. These tram-ways were of especial value in mining and coal districts, where much heavy material required to be transported in various directions; and they rapidly increased in Shropshire, Staffordshire, and the midland counties generally.

An iron tram-road, or railway as it may be called, was in use at Colebrook Dale—a spot celebrated for the erection of the first iron bridge in the world, about the year 1760; for the price of that metal having greatly diminished, it was determined, in order to keep the furnaces at work, to cast some plates to be laid on the upper edge of the wooden tram-roads, which, it was thought, would diminish friction, and prevent abrasion, while they could be taken up and sold as "pigs" in case of a sudden rise. These "scantlings of iron," as they were called, were four inches in breadth, an inch and a quarter in thickness, and five feet long, and were cast with holes to admit of their being easily fastened to the wooden rails beneath. So successful, however, was the application of the plan, that the plates remained undisturbed, and rails of solid iron were gradually substituted through the districts of the country in which tram-ways were required. An iron tram-way was formed from the collieries near Derby to that town; a second, called the Park forest line, was laid down for six miles; and another was constructed near Ashby-de-la-Zouch, which had four miles of

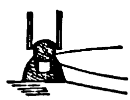
* Life of Lord Keeper Guildford, vol. i. The above passage was written in 1676.

double and eight of single rails. So common, indeed, did tram-ways become, that in 1811 there were in South Wales no fewer than one hundred and eighty miles completed, of which thirty belonged to the Merthyr Tydvil company.

Shortly after the experiment at Colebrook Dale cast-iron rails with



an upright flange were invented, and they seem to have been first used at the colliery of the Duke of Norfolk, near Sheffield. They were originally fixed on cross sleepers of wood, but stone blocks were afterwards substituted. The "edge Railway" was introduced at the slate quarries of Lord Penrhyn in Caermarthenshire. The "metals," as

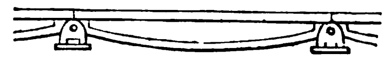


they are called, were between four and five feet long, their section representing an oval, as seen in the diagram. The wheels were formed with a grooved tire, so as to run easily on the rail; but it was subsequently found that the groove became so deepened by wear as to fit the rail tightly, and thus to occasion unnecessary friction. To obviate this difficulty, the bearing surface of the rail and the corresponding part of the wheel were made flat; and thus two horses were enabled to draw a train weighing twenty-four tons with comparative ease, and this power was sufficient to conduct a traffic which, on a common road, would have required no fewer than four hundred.

These railways were chiefly employed in the conveyance of minerals and coals from the mines to the sea-coast, and were extended to wooden platforms projecting over the water at the shipping places, at such an elevation as to allow vessels to pass beneath. The arrangement for emptying the wagons by opening the bottom, and for conducting the coal along inclined shoots immediately into the hold of the vessel, resembled those now adopted. The economy of these and other ingenious contrivances enabled the merchants to export coal at a greatly reduced expenditure, and even to undersell French coal in French ports. "Marseilles," says an intelligent French writer, "affords an example in point. This town, which consumes immense quantities of combustible matter in its great soap-manufactories, is within four or five leagues of a great number of coal mines. This coal is indeed of an indifferent quality, but it is, notwithstanding, employed with advantage in the furnaces of soap-works. Would any one believe that the excellent coal of England, which lasts double the time, and gives double the heat, when sold duty free in the port of Marseilles, is cheaper than the former? Such instances as this," he adds, "ought doubtless to give us very important lessons." *

* Saint-Fond. Travels. Vol. i. p. 146.

The advantages thus derived from the use of the tram-road were highly appreciated and diligently applied; while experience suggested various improvements. "Fish-bellied" rails, as they were denominated, were constructed three or four feet in length, and having their greatest strength in the middle, while the ends were made to over-lap. These were secured one to another in the "chair," or iron box, at which they were united by an iron pin, and the chair being fixed to the sleeper, the whole was made perfectly secure.



In the year 1805, a tram-road was opened between Wandsworth and Croydon, and the advantages which it presented were subjected to a practical test. The draught of a horse on a good road is about fifteen hundred-weight, and strong horses can, under ordinary circumstances, draw two thousand pounds. A party of gentlemen were invited to witness the experiments, that the superiority of the new method might be established on the testimony of ocular demonstration. Twelve wagons were loaded with stones till each wagon weighed about three tons, and a horse being attached, drew them with apparent ease a distance of six miles in an hour and three quarters, having been stopped four times in order to show that he had the power of starting as well as drawing the load. At each of these stoppages, other wagons were added to the train, with which the horse resumed his journey, with apparently undiminished power; and in order still further to show the effect of the railway in facilitating motion, the attending workmen, to the number of about fifty, were directed to mount the wagons, and this additional load was drawn without any apparent effect on the horse. On weighing the load at the end of the journey, it was found to amount to more than fifty-five tons.

In connection with the history of tram-roads, the name of Dr. James Anderson is well deserving of notice. Having devoted many years to the study of mechanical, statistical, and agricultural subjects, this gentleman published a book in 1800, entitled "Recreations in Agriculture," in which he proposed the adoption of lines of Railway along the sides of existing turnpike roads. Though his suggestion referred principally to the draught of heavy loads at slow rates, so that the saving would have been chiefly in horse labour, yet it would have served equally for accelerated motion. By way of demonstrating its practicability, Dr. Anderson proposed that it should be tried between the metropolis and the docks then projected at the Isle of Dogs, and also along the western road to Hounslow; after which, if successful, he recommended that it should be more fully applied on the turnpike

from London to Bath. In his description of the proposed scheme he estimated that heavily-laden wagons could be drawn with one-tenth of the force and cost of the common modes of traffic; the whole to be "kept open and patent to all alike who shall choose to employ them, as the king's highway, under such regulations as it shall be found necessary to subject them to by law."* He subsequently described the method in which these Railways might be constructed; their width, height, gradients, curves, bridges, and even "short tunnels," so that it has been truthfully remarked, that "Dr. Anderson's description might pass for that of a modern railroad."

It does not appear that the proposal attracted much attention at the time, but Mr. Edgeworth advocated a similar scheme two years afterwards, which, he stated, had been long under his consideration. In this he argued that, besides the traffic of heavy vehicles at a slow pace, means might be found of enabling "stage-coaches to go six miles an hour, and gentlemen's travelling carriages to travel at eight, but both with one horse;" while small stationary engines might be erected to perform much of the labour. To this plan it has been objected that it would have required all vehicles to be constructed of the same gauge; but it should be remarked that, as the flange was intended to be fixed to the rail, and not to the wheel, the rail might be of such a breadth as to be adapted to them all. The real difficulty of the proposal consisted in its necessitating the formation of a double line of marginal Railway on our principal roads, requiring a gigantic system of cutting and embanking, of the removal of houses, and the reconstruction of streets, which forms so expensive a feature of the Railroads of the present day.

The stone slabs laid at the sides of the small streets of the metropolis, and the iron gutters which form the margin of the roadway on some of the larger ones and of the bridges, are the only relics—if, indeed, they can be regarded as such—of these schemes. The obvious difficulties overcame the contingent advantages which might have arisen, and the plan was lost in that "oblivion of impracticables," to which so many other projects, however fondly cherished by their originators, have been consigned.

* Recreations in Agriculture. Vol. iv.

CHAPTER II.

A Scene of the Past—A suggestion—Mr. Thomas Gray's scheme of Railway enterprise—Curious anticipations of future results—Efforts for the establishment of his project—Inadequacy of means of communication—Stockton and Darlington line—Mr. Edward Pease—Liverpool and Manchester Railway—Opposition to the scheme—Mr. Stephenson and the Parliamentary Committee—Comparison of horse and steam power—Premium offered for a locomotive—Incredulity of the Quarterly Review and of other authorities—The trial—Description of Liverpool and Manchester line—Opening of the line—Success of Railway enterprise—Public convenience and advantage resulting—London and Birmingham line—Anticipated and real outlay—Biographical sketches of George and Robert Stephenson.

ONE dark night in the year 1784, the venerable clergyman of the town of Redruth, in Cornwall, was taking an evening walk in a long and lonely lane leading to his church, when he heard a most unearthly noise, and, to his horror, beheld approaching him, at a furious speed, an indescribable creature of legs, arms, and wheels, whose body seemed glowing with internal fires, and whose rapid gasps for breath appeared to denote some deadly struggle within. His cries for help brought to his assistance a gentleman of the name of Murdoch, who, no doubt to his infinite relief, explained to him that this terrible apparition, instead of being any embodiment or messenger of the Evil One, was a runaway locomotive, which he, the inventor and proprietor, had incautiously allowed to escape from its leading strings. In this strange manner, what is believed to be *the first locomotive* was introduced to the world; but the public was not then prepared to receive it, and for nearly twenty years nothing was done towards the practical application of Mr. Murdoch's idea.

Time passed on, and the value of tram-roads had become so apparent that they were commonly employed in many districts of the country, and horses and stationary engines dragged along them the heavily-laden wagons of coal and mineral produce. Sometimes, by a fortunate inclination of the ground, the loaded trains were

made to run down by their own impetus, which was also sufficient to drag up the empty ones to be re-filled; while, here and there, a solitary locomotive started along, apparently trying its infantine powers. But the idea of an extensive application of the steam horse on our iron roads was then confined to a few.

A thoughtful man visited one of these tramways in the north of England, which connected the mouth of a colliery with a wharf at which the coals were shipped; and after watching the passing trains for some time, he turned to the engineer of the line, and said, "Why are not these tramroads laid down all over England, so as to supersede our common roads, and steam-engines employed to convey goods and passengers along them, so as to supersede horse-power?" The engineer looked at the questioner out of the corner of his eye, and said,—"Just propose you that to the nation, Sir, and see what you will get by it! Why, Sir, you will be worried to death for your pains." The conversation on this topic terminated; but Thomas Gray, the thoughtful man, did not allow the theme to escape him. Tramroads, locomotive steam-engines, and the superseding of horse-power, engrossed his meditations. "It was his thought by day; it was his dream by night. He talked of it till his friends voted him an intolerable bore. He wrote of it till the reviewers deemed him mad." The system of coaches and canals was, in his estimation, unworthy of the age. His far-reaching anticipations shadowed forth the path which others have since trodden; where they have realized profits, achieved fame, and by means of which an inestimable boon has been conferred on the nation and the world.

In 1820 Mr. Gray published a work, in which he propounded a "general iron railway, or land steam-conveyance, to supersede the necessity of horses in all public vehicles;" and he maintained its "vast superiority in every respect over all the present pitiful methods of conveyance by turnpike roads, canals, and coasting traders." So great was the merit of this work, that, despite the opposition which attended any innovation on the coaching system, it ultimately passed through five editions. The author declared, concerning those who refused to further his scheme:—"Eyes have they, but they see not; they have ears, but they hear not;" while, in full assurance of the ultimate success of his project, he inscribed the following couplets on the plate which illustrated his volume:—

"No speed with this, can fastest horse compare;
No weight like this, canal or vessel bear.
As this will commerce every day promote,
To this let sons of commerce grant their vote."

To readers, thirty years ago, some of Mr. Gray's suggestions were doubtless surprising. After proposing that his plan should be first attempted between the towns of Manchester and Liverpool, he thus described the beneficial results. The convenience and economy in the transport of goods, bought by merchants at the various markets, and the "despatch in forwarding bales and packages to the outports, cannot fail to strike the merchant and manufacturer as points of the first importance. Nothing, for example," said he, "would be so likely to raise the ports of Hull, Liverpool, and Bristol to an unprecedented pitch of prosperity, as the establishment of railways to these ports, thereby rendering the communication from the east to the west seas, and all intermediate places, rapid, cheap, and effectual. Any one at all conversant with commerce must feel 2
the vast importance of such an undertaking, in forwarding the produce of America, Brazils, the East and West Indies, &c., from Liverpool and Bristol, *viâ* Hull, to the opposite shores of Germany and Holland; and, *vice versâ*, the produce of the Baltic, *viâ* Hull, to Liverpool and Bristol." He proceeded to show, that by the establishment of morning and evening "mail steam-carriages," the inland communications would be greatly improved, and the postal conveyance materially aided by the rapidity of transit and the diminution of cost.

Common vehicles, he considered, if proceeding for considerable distances, might be conducted along the railways at equitable terms; and thus, by a due regulation of the arrival and departure of coaches, caravans, and wagons, the entire communication of the country would be so simple and complete, as to enable every individual "to partake of the various productions of particular situations, and to enjoy, at a moderate expense, every improvement introduced into society." In point of economy, the saving would be great; for, instead of each coach "changing" some twenty-five times between London and Edinburgh, and requiring a hundred horses (besides supernumeraries at every stage, in case of accident), a single engine would be the propelling power for a train of vehicles of various kinds. "No animal strength," said Mr. Gray, "will be able to give that uniform and regular acceleration to our commercial intercourse which may be accomplished by railways: however great the animal speed, there cannot be a doubt that it would be considerably surpassed by mail steam-carriages; and that the expense would be infinitely less. The present system of conveyance affords but tolerable accommodation to farmers, and the common way in which they attend markets must always confine them within very limited distances. It is, however, expected that the railway will

present a suitable conveyance for attending market-towns thirty or forty miles off, as also for forwarding considerable supplies of grain, hay, straw, vegetables, and every description of live stock, to the metropolis, at a very easy expense, and with the greatest celerity, from all parts of the kingdom."

After propounding his theory, Mr. Gray most strenuously advocated its practical application. He visited Brussels, and, hearing there a proposal to construct a canal, he urged the superior advantages of a railway. From Belgium he proceeded to Manchester, and laid his scheme before the capitalists of that city; but the men who passed their lives among the marvels of machinery, and owed their fortunes to steam, could not appreciate the project. They listened graciously, and, with a smile somewhat akin to pity, dismissed him as an incorrigible visionary. He petitioned Lord Sidmouth, giving reasons for the adoption of his plan which he thought would be attractive to a statesman. Double or treble the amount of taxes, he said, then levied upon horses and carriages, might be received from the transport of vehicles and their contents on "a general iron railway," while the cost to individuals would be considerably diminished. He subsequently made application to the Government, the Board of Agriculture, and the Lord Mayor and Corporation of London, for their assistance; and in 1827, Mr. Hume presented a petition from him to the House of Commons. The only result of these and other efforts was, that many thought him a knave, and others, who were charitably inclined, pronounced him a simpleton. To appropriate the idea of Mr. Macaulay, "there were fools then as there are fools now; fools who laughed at the railway as they had laughed at the canals; fools who thought they evinced their wisdom by doubting what they could not understand." Still, Thomas Gray persevered; his mind was absorbed in the anticipation of the great and beneficial changes which his scheme would produce. He talked of enormous fortunes realized, of coaches annihilated, of one great general system of iron roads,—and he was laughed at, but not laughed down. He continued to talk, to memorialize, and to fill the pages of magazines, till the public mind was "wearied and worried," and doubtless, not a few wished that railways were established, if it were only that they might be freed from his unceasing importunities.

A few years passed away, and the idea supposed to be born of a disordered imagination became a grave reality, and Thomas Gray found his reward only in himself. In remembrance of his indefatigable and protracted efforts, and the invaluable blessings

which they had materially tended to confer on society, an attempt was subsequently made to give him some pecuniary acknowledgment of national gratitude, but it was unsuccessful. Few men in modern times have served their generation more effectually, and yet received so little compensation in the way of thanks or emolument as Thomas Gray. "He died steeped to the lips in poverty!"

The growing demands which were made by the progress of commerce, soon led to general discontent with the means of intercommunication throughout the country. The tram-roads which had been established, were detached and isolated undertakings for the conveyance of the produce of particular neighbourhoods, and had little effect in mitigating the evil. The want of stimulus to the proprietors and managers of canals, induced a security on their part which not only engendered negligence, but gave them the command of a great monopoly, and the extravagance of their charges was only equalled by the inefficiency of their means of transport. The interruptions which arose from want of water in summer, and from ice in winter,—from their vessels getting aground or being wrecked,—were sufficiently annoying; but to these were added exorbitant fares, and constant delays in the transit.

The delays that often took place in the conveyance of merchandise from Liverpool to Manchester, and *vice versâ*, were very fully stated before the Committee of the House of Commons, in 1825. It was shown that goods had come quicker from New York to Liverpool than they had been conveyed from Liverpool to Manchester. The promoters of the railroad did not rely upon that particular fact; yet it showed the necessity of increasing all sorts of facilities to meet that increased despatch which was kept up at sea. Instances were given, where two months' and three months' delay had taken place, being a longer time than the voyage mentioned; for it was known that goods had come from New York to Liverpool in three weeks. It was not a solitary case: the thing was then (1825) happening daily.

In such a state of things it was not surprising that it was at length resolved that some new and more adequate means should be provided; and, if possible, that the advantages thus secured should be extended to the conveyance of passengers.

The Stockton and Darlington Railway was the first established for public traffic,—the earliest, in fact, of our iron roads on which the question of the carriage of passengers was practically tested. Nor should we, in the greater success of the Liverpool and Manchester Railway, which was subsequently constructed, look slightly on the

Stockton and Darlington. The Act of incorporation for this line was obtained in 1821, and it was opened in the autumn of 1825, horses being then employed as the motive power. Before its formation, the average number of passengers between the two places was fourteen or fifteen weekly; the new line augmented these to five or six hundred. The passengers were conveyed in and on coaches, which usually carried six inside and from fifteen to twenty outside; though, in cases of emergency, passengers were glad to obtain sitting-room where they could. Each carriage was drawn by one horse, and the speed attained was ten miles an hour. The line was thirty-seven miles in length, and at first consisted of a single roadway, with sidings at intervals of every quarter of a mile, for trains proceeding in different directions to pass one another. To the success of the Stockton and Darlington line may be traced the origin of all the others; and to Mr. Pease, its originator, may be ascribed the first practical test of the capacities of a system, truly characterized as a "well-spring of intellectual, moral, and political benefits, beyond all measurement and all price,—creating such a revolution in our internal trade and resources as no thinking man can contemplate without being lost in wonder." To be a leader in such an enterprise is an eminently honourable position; for when the first difficulties had been overcome, and success was proved, others followed with comparative ease and security.

Time passed on, and the difficulties which had pressed upon the merchants of Liverpool, and the manufacturers of Manchester, from the insufficiency of the means of transport, compelled them to adopt some decisive measures. A declaration was drawn up by a hundred and fifty leading men of Liverpool, to the effect that new means of conveyance were indispensable; but before anything further was actually done, application was made to the canal proprietors for a reduction of charge, and an increase of accommodation. To this request a decided negative was returned, and a *hauteur* was manifested throughout the communications by the canal proprietors, which gave no hope of adequate relief to the public. But, as is usual under such circumstances, pride went before a fall; and the pride of gold in this case served only to hasten the progress of those measures which resulted in the establishment of a means of communication between the two great towns, superior in every respect to the old and sluggish canal.

The proposal to construct a railway between Liverpool and Manchester was first made in 1822, but it was not till four years afterwards that the consent of Parliament was obtained to the under-

taking. So moderate were the expectations of the promoters, that the number of passengers between these great towns by railway, was estimated at only half of those who availed themselves of coach accommodation; the transport of manufactures, bales of cotton, coals, minerals, and cattle, being regarded as the staple source of revenue. The approval of the legislature was not secured without a struggle; and the return which was made of the opinions of the landowners, and occupiers of the land which the line had to traverse, is worthy of record.

Landowners.		*Occupiers.*	
Assents	152	Assents	302
Dissents	86	Dissents	128
Neuters	97	Neuters	66
	335		496

The engineers examined in favour of the Bill were Messrs. Rennie, Stephenson, Cubitt, Rastrick, and Vignolles; those against it being Messrs. Giles, Leather, Wild, Smith, and Palmer.

The Bill, after much opposition, became law; and when the works of the new line were at length approaching completion, it was necessary that a decision should be made as to the motive agency to be employed,—an essential point, which had not yet been absolutely determined. Horse-power was at first proposed, but soon found to be altogether inadequate; and the choice now lay between locomotive and stationary engines. If the latter had been selected, they would have been employed in the following manner:—A rope would have been carried along the line, between the rails, to which the wagons containing the passengers or merchandise would have been attached; and this being at certain intervals coiled round large drums or cylinders, the wagons would have been drawn from station to station by fixed steam-engines, applied to keep these drums or cylinders in revolution.

In the spring of 1829, the Directors of the Company engaged Messrs. Stephenson, Locke, Walker, and Rastrick, to collect information from the managers of the various railways of the country, as to the best power that could be applied, and especially to report on the comparative merits of locomotive and fixed engines. For this purpose they visited all the principal railways in the north of England, made the most minute and careful inquiries as to the vehicles and species of moving power employed on them, and then gave the result of their investigation in separate reports. The following were the general conclusions arrived at:—

Capital necessary on the locomotive system	£91,000
Ditto on the stationary system	101,000
Difference in favour of the locomotive	£10,000
Annual expense and interest of capital on locomotive system	£43,000
Ditto, ditto, on stationary system	33,000
Difference in favour of stationary system	£10,000

Locomotive system, rate per mile	·2787	of a penny
Stationary system, ditto	·2134	do.
Difference, 1-16th of a penny, or	·0653	do.

The rate by the two systems was thus as seven to nine in favour of the stationary engines; but it was at the same time admitted, that improvements were then being effected in the construction of locomotives, which made it very probable that their efficiency would be materially increased. It was thought, too, that in the stationary system accidents would be less frequent; but that, when they occurred, they would be more injurious, as they would extend to the whole line. In the locomotive system they would be confined to the single engine that was disabled, and to its train. In the stationary system perfect uniformity from end to end must be preserved; in the locomotive system, one engine, with its train, by passing to the sidings, might stop any length of time that was found necessary, without preventing the others pursuing their course. Hence it was concluded that, having reference to economy, dispatch, safety, and convenience, if it were resolved to make the Liverpool and Manchester railway complete at once, the stationary reciprocating system was the best; but that, if any circumstances should induce the Directors to proceed by degrees, and to proportion the power of conveyance to the demand, then it was recommended that locomotive engines should be employed upon the line generally, and that two fixed engines should be placed at Rainhill and Sutton, to draw the locomotive engines, as well as the goods and carriages, up the inclines at these places.

Up to this period, the transport of passengers on the proposed railway had not formed any special feature in the calculations of its advocates; but it was now suggested that locomotives might possibly be so constructed, as to convey passengers at a speed equal to that attained by coaches.

In order to attract the attention of men of science to the subject, a premium of £500 was publicly offered for the best locomotive that could, under certain stipulations, be constructed; and though the

sum was comparatively insignificant in itself, yet it was obvious, that on the successful engineer would devolve the construction of the entire "stud" of locomotives for the new line. The company required of the competing engines, that they should consume their own smoke; that, if they weighed six tons each, they should be capable of drawing a train of twenty tons weight, including the tender, at a speed of ten miles an hour, on a level railway; that each should have two safety-valves,—one beyond the control of the engine-driver; and that their height, including the chimney, should not exceed fifteen feet. It was also announced, that preference would be given to an engine of less weight, if it performed an equal amount of work; that the Company was to be at liberty to test the machinery; and that the price of the successful competitor was not to exceed £550.

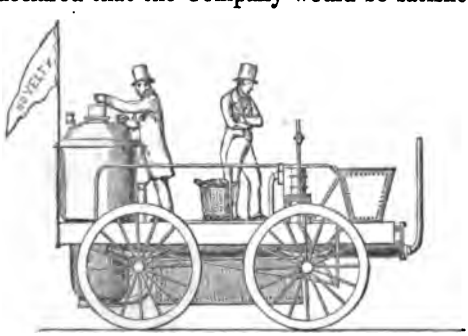
Now that the results of this great enterprise are before the world, it is curious to observe how completely they were unforeseen. The idea of a steam-engine drawing a heavy load, at a speed of twelve miles an hour, was received with ridicule by the most eminent engineers of the day. One distinguished writer on railways, who resided in the heart of a coal country, and under whose windows locomotives had been working for years, indignantly disavowed any participation in such extravagant speculations, and has left his disclaimer on record in a published work. "It is far from my wish," said he, "to promulgate to the world that the ridiculous expectations, or rather professions, of the enthusiastic speculatist will be realized, and that we shall see engines travelling at the rate of twelve, sixteen, eighteen, and twenty miles an hour. Nothing can do more harm towards their general adoption and improvement than the promulgation of such nonsense!"*

"As to those persons," said the *Quarterly Review*, "who speculate on making railways generally throughout the kingdom, and superseding all the canals, all the waggons, mails, and stage-coaches, post-chaises, and, in short, every other mode of conveyance, by land and by water, we deem them and their visionary schemes unworthy of notice. Every particular project must stand or fall by its own merits; and we are greatly mistaken if many of those which are already announced will not, when weighed in the balance, 'be found wanting.' The gross exaggerations of the powers of the locomotive steam-engine (or, to speak in plain English, the *steam-carriage*), may delude for a time, but must end in the mortification of those concerned. What, for instance, can be more palpably absurd and ridiculous than the following paragraph, in one of the published proposals of what we

* It is believed that *no* allusion is here made to Mr. George Stephenson.

should call a hopeless project?" * The scheme here alluded to was of laying down a railway between the metropolis and Woolwich, in which it was considered that "twice the velocity" of the coaches might be attained, combined with "greater safety." The anticipation that, by the agency of steam, travellers would some day proceed "at the rate of four hundred miles a-day, with all the ease we now enjoy in a steam-boat, but without the annoyance of sea-sickness, or the danger of being burnt or drowned," called forth the indignation of the reviewer. "But with all these assurances," he adds, "we should as soon expect the people of Woolwich to suffer themselves to be fired off upon one of Congreve's *ricochet* rockets, as trust themselves to the mercy of such a machine, going at such a rate."† An opinion thus expressed by authorities of such eminence, in opposition to what is now an every-day reality, may well induce the most intelligent and far-sighted to hesitate in dogmatical assertions as to what may or may not be the revelations of the future.

The merits of the competing engines for the Liverpool and Manchester railway, were determined by the Directors, assisted by Messrs. Rastrick, Kennedy, and Nicholas Wood; it having been previously declared that the Company would be satisfied if a speed of ten miles were attained. On the day appointed, the *Rocket*, constructed by Mr. George Stephenson; the *Novelty*, by Messrs. Braithwaite and Ericson; and the *Sans Pareil*, by Mr. T. Hackworth, entered the lists, on a piece of railroad which had been selected between Liverpool and Manchester. In consequence of this space being little more than a mile and a half long, each engine had to travel the whole distance backwards and forwards ten times, making a journey of thirty miles. In order that the performances of each might be accurately tested, a judge was stationed at each end of the real running course, who noticed the exact time at which the engines passed; the additional ground at each end being allowed to them for getting up their speed. When the *Sans Pareil* was examined, it was found not to have been

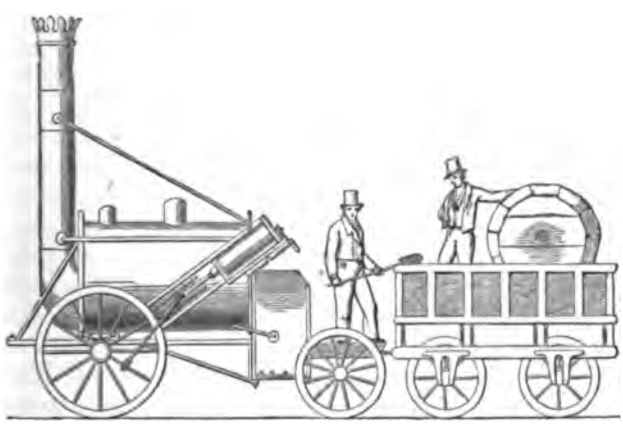


THE NOVELTY.

* *Quarterly Review*, Vol. XXXI., p. 361.

† *Quarterly Review*, p. 362, years 1824-5.

constructed in precise accordance with the stipulations of the Company, and therefore was, in strictness, disqualified; but it was resolved that a trial should be made, and that, if it displayed marked superiority, it should be recommended to the favourable consideration of the Directors. On its eighth trip, however, the pump that supplied the water failed, and this occasioned an accident which terminated the experiment. The *Novelty* succeeded only in passing twice between the stations, further trial being prevented by the joints of the boiler giving way. The *Rocket* having been supplied with water, was weighed, and the load to be conveyed was then attached, forming an aggregate of seventeen tons. This engine twice performed the entire distance of thirty miles; the first time in about two hours and a quarter, and the second in about two hours and seven minutes. Its greatest speed was at the rate of thirty miles an hour, and the average about fourteen. The marked superiority exhibited by the



THE ROCKET.

Rocket was chiefly owing to the use of a tubular boiler, by which a very large surface was brought in contact with the fire, and a proportionate amount of steam generated. The engine, also, consumed less coal than the others, in the proportion of eleven to twenty-eight. The boiler consisted of a flat cylinder, six feet in length, having flat ends; the chimney issued from one extremity, and to the other the fire-place was attached, which, externally, had the appearance of a square box.

Mr. Stephenson, having thus been the successful competitor, was appointed to construct the engines of the railway, and from that

period to his recent lamented death, he conducted the engineering department of the Company.

The construction of the works of the Liverpool and Manchester railway required immense and unremitting labour. Besides the embankment over Chat Moss, to which we shall have to refer again, there was the building of viaducts, the formation of cuttings and embankments, the erection of sixty-three bridges, and the construction of a tunnel, to convey passengers underneath an elevated piece of ground in the neighbourhood of Liverpool; besides the laying down of the permanent way, the erection of stations and warehouses, and the preparation of the engines, carriages, and wagons. The work was nearly completed in May, 1830, at a cost of twenty-four thousand pounds a mile, the outlay being as follows:—

Cuttings and Embankments	£199,763
Chat Moss	27,719
Tunnel	47,788
Land	95,305
Fencing	10,202
Bridges	99,065
Formation of Road	20,568
Laying of Blocks and Sleepers	20,520
„ Rails (£12 10s. per ton)	60,912
Surveying, Law, Parliamentary, and Incidental	157,341
	£739,183

Every preparation was made for the opening of the line on the 15th of September, 1830, when the Duke of Wellington, Prime Minister; Mr. Peel, Home Secretary; Mr. Huskisson, and a number of other distinguished persons, had agreed to pass in the first train with the Directors. A gay *cortège*, consisting of thirty-three carriages, and accompanied by bands of music, started from Liverpool, amidst the acclamations of a countless multitude of observers, and with all the splendour of an ancient pageant. But soon the enjoyment of the scene was marred. While the engines were stopping to take in water at Parkside, Mr. Huskisson, with some other gentlemen, strolled along the line. As they were returning to their seats, another train of carriages came up. All ran to obtain shelter; but Mr. Huskisson hurried to the side of the train, and, opening the door, attempted to enter, but the door swung back at the moment—he fell to the ground, and was in an instant overthrown, and crushed beneath the wheels of the advancing carriages. His thigh was fractured and mangled, and his own first expression, "I have met my

death," proved too true, for he died that evening in the neighbouring parsonage of Eccles. The train passed on to Manchester without further accident; but the contemplated festivities were forgotten amidst the gloom occasioned by this tragical occurrence.

Of the events of that memorable day, both in the wonders achieved and in the sad interest of the death of Mr. Huskisson, Lord Brougham has spoken with his usual force and eloquence. "When I saw," he said, "the difficulties of space, as it were, overcome; when I beheld a kind of miracle exhibited before my astonished eyes; when I surveyed masses pierced through, on which it was before hardly possible for man or beast to plant the sole of the foot, now covered with a road, and bearing heavy wagons, laden not only with innumerable passengers, but with merchandise of the largest bulk and heaviest weight; when I saw valleys made practicable by the bridges of ample height and length which spanned them; saw the steam railway traversing the surface of the water, at a distance of sixty or seventy feet perpendicular height; saw the rocks excavated, and the gigantic power of man penetrating through miles of the solid mass, and gaining a great, a lasting, an almost perennial conquest over the power of nature, by his skill and industry; when I contemplated all this, was it possible for me to avoid the reflections which crowded into my mind—not in praise of man's great success; not in admiration of the genius and perseverance he had displayed, or even of the courage he had shown in setting himself against the obstacles that matter offered to his course—no! but the melancholy reflections that all these prodigious efforts of the human race, so fruitful of praise, but so much more fruitful of lasting blessings to mankind, have forced a tear from my eye, by that unhappy casualty which deprived me of a friend, and you of a representative."

The success of the undertaking, in a commercial and mechanical point of view, was, from the first, decided. The number of passengers who availed themselves of the line was as follows:—

In the year 1831	445,047
„ 1832	356,945
„ 1833	386,492

The receipts for passengers were—

In 1831	£101,829
„ 1832	88,165
„ 1833	98,816
„ 1834	111,063
„ 1835	120,336
Total Receipts in 1835	217,430

Against this enormous sum for 1835, there must be placed the interest upon an expenditure which amounted, in June of that year, to £1,171,386, besides the wear and tear of property, and all the expenses of the establishment. In the half year ending at the last-mentioned date, the expenses amounted to £61,814, including above £16,000 for locomotive power, and more than £2000 for rates and taxes. So large, however, were the profits, that, for every hundred pound share, the proprietors received, each half year, from four guineas to four pounds ten shillings; till, at the latter half of 1835, they obtained five pounds, or at the rate of ten per cent. In June, 1834, the Company employed 64 agents, clerks, and outlookers, 636 engine-men, guards, labourers, and others, whose salaries and wages amounted to £800 a week.

The advantages that accrued to the public from the establishment of the Liverpool and Manchester line, were very great. The increased facilities of communication occasioned a large increase of the number of travellers. Before the establishment of the railway, there ran between those towns twenty-two regular, and about seven occasional coaches, which, if full, could carry only 688 persons a day. The railway, on the other hand, carried 700,000 persons during the first eighteen months it was open, being an average of 1070 a day; while a vast augmentation took place in the amount of goods conveyed, and in the rapidity of transit. The saving to manufacturers in the neighbourhood of Manchester, in the carriage of cotton alone, very soon amounted to about £20,000 a year; while some houses in this item saved £500 per annum. New factories were established, and even new coal-pits were sunk near the line, giving increased employment; and while thus reducing the number of claimants for parochial relief, the line paid one-fifth of the poor-rates in the parishes through which it passed. Time, too—which is money—was also economized; and if we estimate the yearly number of persons travelling on that line at half a million, and suppose each one to save or gain an hour in the time of transit, there would be at once a clear gain of five hundred thousand hours, or of fifty thousand working days of ten hours each; and this is equivalent to the actual power of no fewer than a hundred and sixty-seven men.

The traffic in goods, though large, fell far short of what had been anticipated. The tariff of the canal was lowered to the level of the railway charges, and speed and attention to the accommodation of customers were increased. The canal also possessed this important advantage over the railway—that, as it wound through Manchester, its waters touched the walls of the warehouses of the merchants

and manufacturers, while it terminated at the Liverpool Docks, thus avoiding great inconvenience and expense in the cartage of goods by land. But the superior speed of the railway was, on many accounts, an important consideration, and the Company soon found themselves carriers of merchandise to a very large extent.

The success of the Liverpool and Manchester line destroyed all doubt as to the possibilities of the railway system. It was now and for ever *un fait accompli;* and it was not long before its advantages were sought in other parts of the country. Branches were made from the main line to Warrington on the south, and to Bolton on the north, besides one or two others of minor importance. At a later period, Birmingham was united to Warrington, and consequently with Liverpool and Manchester, by the Grand Junction Railway.

It was subsequently resolved to form a line from London to Birmingham, and in 1830, two Companies started on this enterprise. By one, it was proposed to proceed by Oxford and Banbury, by the other, to pass close to Coventry. Each Company had its separate staff of directors and officials; but, foreseeing the danger and loss which must inevitably result from the competitive struggle between two such formidable public bodies, they wisely entered into an arrangement for the union of the two, which was effected in September, 1830. In consequence of Mr. George Stephenson being decidedly in favour of the route by Coventry, the preference was given to this line; and before the close of the year, preliminary inquiries and plans were instituted, and surveys made of the country through which the line was to pass. During the following year, these were concluded, together with estimates of the expenses of the works. Application was then made to Parliament to bring in a bill to sanction the accomplishment of the scheme. And here it may be well to give the estimate then laid before Parliament of the cost: it will be seen hereafter how wide the calculations were of the actual amount.

Excavations and Embankments	£179,000
Tunnelling	250,286
Masonry	350,574
Rails, Chairs, Keys and Pins	212,940
Blocks and Sleepers	102,960
Ballasts and laying Rails	102,960
Fencing	76,032
Land	250,000
Water Stations, and Pumps	3,600
Offices, &c.	16,000
Locomotive Engines, Wagons, and Coaches	61,000
Contingencies	294,648
	£1,900,000

The bill was read a third time, and passed in the Commons, in June, 1832, but was lost a few days afterwards in the House of Lords, the following motion of Lord Brownlow being agreed to:—"That the case for the promoters of the bill having been concluded, it does not appear to the Committee that they have made out such a case as would warrant the forcing of the proposed railway through the land and property of so great a proportion of dissentient landowners and proprietors."

The bill, however, was again brought before Parliament, and received the sanction of the Lords in April, 1833. The causes that contributed to modify the asperity of the aristocratic portion of the legislature, or of the landed interest, have led to much speculation among the curious, especially as no alteration in the route of the line was made.

The real expense of the line was far beyond the sum originally estimated. In February, 1840, the total amount received was more than £5,276,000, nearly the whole of which had been expended. Of this sum, the land cost no less than £600,000. The line was opened throughout, on the 7th of September, 1838.

Before concluding this chapter, some reference must be made to two individuals whose names are intimately connected with the rise and progress of the railway system, and whose remarkable career is worthy of the study of all. We refer to George and Robert Stephenson, who, from the humblest origin, have risen to an eminence to which the vast benefits they have conferred upon the world have most justly entitled them.

The early life of George Stephenson affords a singular contrast to his subsequent history. Born in a small cottage, in the village of Wylam, on the banks of the Tyne, near Newcastle, the son of a colliery workman, he had early to labour for his share of the household bread. Heavy were the demands upon him. As soon as he was able to do anything, we find him at plough, "from morn to noon, from noon to dewy eve," even when "too young to stride across the furrow." Then we see him picking bats and dross from the coal-heaps, at two-pence a day, when he was so young that he often hid himself when the overseer passed, lest he should be thought too little to earn his wages. Shortly after he entered his teens, he worked as breaksman on a tram-way, and subsequently became stoker to an engine on an estate of Lord Ravensworth, often having to rise to his duties at one and two o'clock in the morning, and work till a late hour at night. Thankful in the receipt of a wage of a shilling a day, he declared that he was "a man for life" when this amount was doubled.

He was still a stoker—but a thoughtful and observant one. And when, at length, an opportunity was afforded of displaying his abilities in some repairs which were required in the machine he tended, he clearly showed the native ingenuity which dwelt beneath his rough exterior. Yet his circumstances were far from cheering. In the year 1800, the scourge of war, with famine in its wake, was raging over Europe. Wages were low and food was dear, while the militia or the press-gang imperilled the occupation of the artisan; and we find George Stephenson seriously contemplating emigration to the New World, as a more fitting field for his labours. With a keen and painful recollection of the embarrassments of that period, he afterwards remarked to one who was well acquainted with him: "You know the road from my house at Killingworth, to such a spot.—When I left home and came down that road, I wept, for I knew not where my lot would be cast."

As his prospects somewhat improved, he gave up the thought of emigration, and when he reached the age of twenty-two, he married. In 1803, his only child, Robert, was born. With his increasing duties the father became, if possible, still more industrious. He tried his hand at all kinds of work, and while he availed himself of every opportunity of personal improvement, he cut out clothes for the pitmen, taught the pitmen's wives, and made shoes for his poorer relatives.

Meanwhile, his powers of invention and contrivance had developed themselves in various ways, and had brought with them what may be fairly designated a local celebrity. So decided was his ability, and so great was the confidence Lord Ravensworth and the Killingworth owners had in him, that they supplied him with money to make a locomotive, and in the month of July, 1814, it was tried on a tramway. "Yes," said Stephenson himself, in a speech which he delivered at the opening of the Newcastle and Darlington Railway, in June, 1844, "Yes, Lord Ravensworth and Co., were the first parties that would intrust me with money to make a locomotive engine. That engine was made thirty-two years ago. I said to my friends, that there was no limit to the speed of such an engine, provided the works could be made to stand. In this respect, great perfection has been reached, and, in consequence, a very high velocity has been attained. In what has been done under my management, the merit is only in part my own. I have been most ably assisted and seconded by my son. In the earlier period of my career, and when he was a little boy, I saw how deficient I was in education, and made up my mind that he should not labour under the same defect, but that I

would put him to a good school, and give him a liberal training. I was, however, a poor man; and how do you think I managed? I betook myself to mending my neighbours' clocks and watches at night, after my daily labour was done; and thus I procured the means of educating my son. He became my assistant and my companion. He got an appointment as under reviewer, and at night we worked together at our engineering. I got leave to go to Killingworth to lay down a railway at Hetton, and next to Darlington; and after that I went to Liverpool, to plan a line to Manchester. I there pledged myself to attain a speed of ten miles an hour. I said I had no doubt the locomotive might be made to go much faster, but we had better be moderate at the beginning. The Directors said I was quite right; for if, when they went to Parliament, I talked of going at a greater rate than ten miles an hour, I would put a cross on the concern. It was not an easy task for me to keep the engine down to ten miles an hour; but it must be done, and I did my best. I had to place myself in that most unpleasant of all positions—the witness-box of a Parliamentary Committee. I could not find words to satisfy either the Committee or myself. Some one inquired if I were a foreigner, and another hinted that I was mad."

Strange as these statements may now appear, it was literally true that he was regarded as "of unsound mind." With this opinion of the engineer, many of the shareholders sympathized. They became alarmed at the "mad" scheme of the "Watt run wild;" and "in order," says a recent writer, "to prevent his no less mad steam-engines from being let loose upon their cherished horse-trot railway project, they got two 'eminent engineers' to act as commissioners of lunacy, and to report. The 'eminent engineers' accordingly investigated the subject, and in 'a very able document,' proved most clearly that Mr. Stephenson's project was practically and commercially inexpedient!"

But to return to Stephenson's simple and beautiful narrative. "I put up," he continued, "with every rebuff, and went on with my plans, determined not to be put down. Assistance gradually increased—improvements were made—and to-day, a train, which started from London in the morning, has brought me in the afternoon to my native soil, and enabled me to take my place in this room, and see around me many faces which I have great pleasure in looking upon."

Mr. Stephenson's connexion with the Liverpool and Manchester Railway, to which reference has already been made, brought him into the front rank of the engineers of his day. He became an extensive locomotive manufacturer at Newcastle, a railway contractor, and a

great colliery and iron-work owner, particularly at Clay Cross. It is recorded of him, that in reply to the inquiry of a lady, he said, in review of his past career:—"Why, madam, they used to call me George Stephenson; I am now called George Stephenson, *Esquire*, of Tapton House, near Chesterfield. And, further, let me say, that I have dined with princes, peers, and commoners, with persons of all classes, from the humblest to the highest. I have dined off a red-herring when seated in a hedge-bottom, and I have gone through the meanest drudgery. I have seen mankind in all its phases, and the conclusion I have arrived at is this,—that if we were all stripped, there is not much difference."

Of the honours conferred upon George Stephenson we need not speak. Though these were numerous and distinguished, they did not elevate him, for they could not. Without disparaging their intrinsic utility and excellence, they serve but as indications that there were persons of public influence in this and in other lands who had sense enough to understand the worth of such a man, and as tokens of such appreciation they are valuable and honourable to their possessor. Mr. Stephenson's death occurred in August, 1848.

Robert Stephenson, whose early career has been somewhat anticipated in our sketch of his father's life, was born at Wilmington. When a lad, he served for three years as a coal-viewer to Mr. Nicholas Wood; and, as better prospects opened up to his father, who was beginning to become known as an engineer, he attended the University of Edinburgh for one session. During that period there was not a more diligent student there. He knew the value of knowledge, applied himself most earnestly to its pursuit, and there learned how to teach himself. In 1822 he returned from Edinburgh, and commenced his apprenticeship to engineering, under his father, who had just established a steam-engine factory at Newcastle. But two years of laborious application to the study and practice of his profession, gave evidence, in his failing health, of the fact, that he was doing too much even for his robust frame. It happened at that time that an expedition had been arranged for exploring the silver and gold mines of Venezuela, New Grenada, and Colombia, the charge of which was offered to him, and it was accepted. The change of work and of climate were the means of restoring his health, and on his way home, in 1828, he met with Mr. Trevithick the engineer, from whom he gathered much information in reference to the mines of Cornwall, which materially tended, by its application to the construction of locomotives, to his ultimate success in that department.

During the absence of Robert Stephenson from England, a new era had arisen in our railway history. The Liverpool and Manchester line was nearly finished, and the question, whether locomotive steam-engines were to be used or not, had to be decided. With this part of the history our readers are already familiar.

The success of the *Rocket* encouraged Robert Stephenson to devote his attention with renewed earnestness to the construction of locomotives, and by simplifying the working parts of the engine, increasing the steam-generating capacities of the boiler, and varying the proportions of several parts of the engine, he obtained a great increase both of power and speed. Each engine that issued, month by month, from the factory, was an improvement on its predecessors, until the fourteen and twenty miles of the *Rocket* were raised to sixty, and even seventy miles; and the Newcastle factory became the largest and most famous in the world. As railways increased, it sent engines to all the countries of Europe, and to the United States, and it has manufactured about a thousand locomotives. A writer in October, 1850, said, while speaking of the achievements of railway enterprise, especially under the auspices of Mr. Stephenson, that we then had about 5000 miles of railway, in the construction of which, 250,000,000 cubic yards, or not less than 350,000,000 tons of earth and rock, had, in tunnel, embankment, and cutting, been removed.

During the construction of the London and Birmingham Railway, Mr. R. Stephenson, having entered into an arrangement with the Directors of that Company to give his time wholly to the construction of their line, removed to the metropolis, where he was busily employed in superintending the prosecution of the works. He then planned the construction of an extensive system of railways in Belgium, extending on the one hand from Ostend to Liege, and on the other, from Antwerp through Brussels, to be connected through Mons with Valenciennes, and making altogether 347 miles of railway.

On the completion of the London and Birmingham, the Stephensons undertook the formation of the Birmingham and Derby, North Midland, York and North Midland, Manchester and Leeds, Northern and Eastern Railways, and for ten years were incessantly engaged upon the surveys, plans, parliamentary battles, and construction of the vast network of lines stretching in all directions throughout the kingdom. During this period, Robert Stephenson, as engineer-in-chief, executed the great iron cross of roads which on the one hand unite London with Berwick, and on the other, Yarmouth with Holyhead, making, with the lines in connexion with them, not less than 1800 miles of the entire iron highways of the country.

In the year 1846, in company with Mr. G. P. Bidder, Robert Stephenson visited Norway, to examine the country for the purpose of a railway between Christiana and the Myosen Lake, a distance of forty miles, and had honours conferred upon him in acknowledgment of his able services, by the King of Norway and Sweden, as he had previously from the King of Belgium.

To the works conducted by Robert Stephenson the attention of the reader will be frequently directed. Among these may be mentioned the High Level bridge over the Tyne at Newcastle; the Tweed Viaduct; the tunnellings and other works on the Chester and Holyhead; and the Conway and Britannia tubular bridges.

On the occasion of a public dinner being given to Mr. R. Stephenson, at Newcastle-upon-Tyne, in August, 1850, he traced, in brief but expressive words, his career in connexion with the progress of railway enterprise. "It was but as yesterday," he said, "that he was engaged as an assistant in tracing the line of the Stockton and Darlington Railway. Since that period, the Liverpool and Manchester, the London and Birmingham, and a hundred other great works, had sprung into vigorous existence. So suddenly, so promptly, had they been accomplished, that it appeared to him like the realization of fabled powers, or the magician's wand. Hills had been cut down, and valleys had been filled up; and where this simple expedient was inapplicable, high and magnificent viaducts had been erected; and where mountains intervened, tunnels of unexampled magnitude had been unhesitatingly undertaken. Works had been scattered over the face of our country, bearing testimony to the indomitable enterprise of the nation, and the unrivalled skill of its artists. In referring thus to the railway works, he must refer also to the improvement of the locomotive engine. This was as remarkable as the other works were gigantic. They were, in fact, necessary to each other. The locomotive engine, independent of the railway, would be useless. They had gone on together, and they now realized all the expectations that were entertained of them. It would be unseemly, as it would be unjust, if he were to conceal the circumstances under which these works had been constructed. No engineer could succeed without having men about him as highly gifted as himself. By such men he had been supported for many years past; and though he might have added his mite, yet it was to their co-operation that all his success was owing."

Of the subject of this sketch it has been well said, that, "healthy-bodied and healthy-minded, apt in emergencies, and yet of slow, and generally of sound judgment, Robert Stephenson may be regarded as

the type and pattern of the onward-moving English race, practical, scientific, energetic, and, in the hour of trial, heroic. Born almost in the coal-mine, of the racy old blood of the north, with a father strong in mother-wit, stern of purpose, untiring in patience, careful of his small resources, keenly conscious of the bounded sphere his want of early education had kept him in till a later period of life, and determined to pare off from himself all luxuries, all but the merest necessaries, in order that his after-coming should start fair in life with that knowledge he himself held above all price—born thus, Robert Stephenson was emphatically *well-born*. With natural talents, good education, a healthy frame, the rising *prestige* of his father's name, little money, and a large demand for original work in a working and energetic old world, he went forth to the New World, and in the mines of South America and their environs, added new manners and customs to his varied stock of knowledge. More than all this, the genial spirit that ever looked kindly on his fellow-creature, with the intellect that could generally winnow the false from the true, marked him out for a leader of men. Not to his mere mechanical skill does he owe his success in life. That might have been thwarted in five hundred ways by interested rivals; but men wish not to thwart those whom they love; and probably no chief of an army was ever more beloved by his soldiers than Robert Stephenson has been by the noble army of physical workers, who, under his guidance, have wrought at labours of profit,—made labours of love by his earnest purpose and strength of brotherhood."*

* Westminster and Foreign Quarterly Review.

CHAPTER III.

Objections to Railways—Opposition of the Towns of Northampton, Oxford, and Eton—Colonel Sibthorp's Views on the Railway System—Other Objections—William Wordsworth—Modification of Popular Prejudice—Progress of Railways—Projects in 1844—Rivalry—Legislative Decisions in Reference to Railways—Amalgamation of Lines in 1845—Sketch of the Commercial History of Railways—Laudation of Railways by some Portions of the Press—Popular Excitement in reference to Railways—The Railway Mania—How to make a Prospectus—Ingenious Device—Universality of the Influence of the Mania—Localities of Railway Enterprise—Provisional Directors—Serious Condition of Affairs—Efforts of Provisional Committees—Follies of the South-sea Bubble re-enacted—"Stags," their Natural History and Habits—Mr. Hudson, his Connexion with the History of Railway Speculation—Revulsion of Popular Feeling in reference to Mr. Hudson—Estimate of his Position and Career—Thomas Carlyle's View of George Hudson—Parliamentary Interference—Depositing of Plans at the Offices of the Board of Trade—Surveying and Levelling—Amusing Incidents—Demands for Lithographic and Zincographic Draughtsmen—"Sharp Practice"—Prompt Measures of the Attorney of the Dudley, Neadely, and Ironbridge Line—Scotch and Irish Projects—Scenes at the Offices of the Board of Trade, on the 30th of November, 1845—Statistics of Railways—Cost of the Mania—The "Back Out"—Miserable Conclusion of the Drama—The "Break Up"—Parodies—Results of the Mania—Subsequent History of Railway Speculations—Deception—Public Incredulity—Position of Railway Property.

AS the railway and the locomotive were gradually brought into general application, the indifference or contempt with which many had regarded the whole system was changed into the sincere and determined opposition of those who felt that their vested interests were in danger. Success, great and incontrovertible, however, rewarded the efforts of science, and difficulties which had been pronounced and believed to be insuperable, were overcome. The public began to regard the railway system as "a great fact," and the prejudices of the minority were modified by hearing of works accomplished, and instances of unusually rapid transit performed. But this only augmented the hostility of others, while not a few viewed the entire scheme with unmingled horror. Some opposed

railways on a great principle,—because they were only an attempt to supersede stone roads by iron; and they quoted bluebooks to prove, that if the advocates of the new scheme were successful,—which they did not for a moment believe,—they would render useless the 27,000 miles of turnpike-roads in Great Britain, to say nothing of the other public and cross roads of the country.

A rumour that it was proposed to bring such a thing as a railroad within a dozen miles of a particular neighbourhood, was sufficient to elicit an adverse petition to Parliament, and a subscription to oppose so fearful a nuisance. The London and Birmingham line was thus compelled to change its intended route through Northampton, and to keep at a respectful distance; lest, said some of the worthies of that town, the wool of the sheep should be injured by the smoke of the locomotives (though they burn coke); and therefore—philanthropic souls!—they required that the purity of their fleeces should be preserved unsullied from the plutonic cloud, by giving the benefit of it to the farmers of Blisworth and its neighbourhood. This argument is somewhat enriched by the remembrance of the fact, that Northampton is chiefly known as a large boot and shoe manufactory. Nor would those seats of learning, Oxford and Eton, permit the Great Western bill to pass, without the insertion of special clauses to prohibit the formation of any branch to Oxford, or of a station at Slough; while it was declared by the authorities of the school, that anybody acquainted with the nature of Eton boys, would know that they could not be kept from the railway if it were allowed to be constructed. When the Directors subsequently attempted to infringe the conditions with which they had been bound, by only stopping to take up and set down passengers, proceedings were commenced against them in Chancery, and they were interdicted from even making a pause.

In the discussion in the House of Commons on one bill, it was urged by one honourable gentleman, that trains could not possibly go faster than ten miles an hour; by another, that the whole scheme was a flagrant imposition; and Sir Isaac Coffin exclaimed, with a sublimity of eloquence and a depth of pathos which must have greatly agitated all his hearers,—"How would any person like to have a railroad under his parlour window?"

By another it was stated, that the introduction of the new system of locomotion would overthrow the business of very important sections of the community. "The beauty and comfort of gentlemen's estates would be destroyed by it. Was the House aware of the smoke and the noise, the hiss and the whirl, which locomotive

engines, passing at the rate of ten or twelve miles an hour, would occasion? . . It would be the greatest nuisance, the most complete disturbance of quiet comfort in all parts of the kingdom, that the ingenuity of man could invent."

A gallant Colonel, too, assured the House of Commons, that "railways were dangerous and delusive speculations;" that "such schemes were dangerous, delusive, unsatisfactory, and, above all, unknown to the constitution of this country;" and that "he hated the very name of a railway—he hated it as he hated the devil."

When the London and Birmingham line was proposed, a whole chorus of voices shouted objections, or uttered withering sarcasms on the project. It was declared that it would be "a drag on the country;" that its works would soon be ruins for the antiquary to study; "and that every hill and valley between the two towns would behold falling arches and ruined viaducts." Others affirmed, that canals would soon attain such efficiency, that railways would be superfluous; that the charge for transit by the canals would be far less than by their rivals, and the speed very much greater. Medical men asserted that the tunnels would be peculiarly dangerous in producing colds, catarrhs, and consumption; and that the deafening peal, the fearful gloom, the clanking chains, the dismal glare of the locomotive, and a thousand other horrors, which they vividly depicted, were so alarming, that such inventions ought to be utterly repudiated.

Long afterwards, when railways had been extensively constructed, a poet laureate at Rydal Mount penned touching lines on hearing that a branch was about to be made from Kendal to Windermere:—

"Is there no nook of English ground secure
From rash assault? Schemes of retirement sown
In youth, and 'mid the busy world kept pure
As when their earliest flowers of hope were blown,
Must perish; how can they this blight endure?
And must he, too, his old delights disown,
Who scorns a false, utilitarian lure
'Mid his paternal fields at random thrown?
Baffle the threat, bright scene, from Orrest-head,
Given to the pausing traveller's rapturous glance!
Plead for thy peace, thou beautiful romance
Of nature; and if human hearts be dead,
Speak, passing winds; ye torrents, with your strong
And constant voice, protest against the wrong!"

By others, the railway system was characterized as "a monopoly the most secure, the most lasting, the most injurious, that can be conceived to the public good;" as "a sordid vehicle of gain;" and

the world was assured that it was about to be "placed at the mercy of individuals induced by no motive to action but their own selfishness, swayed by every gust of prejudice and passion, and too often as profoundly ignorant of even their own real interest, as they are exclusively devoted to its advancement."

But prejudice, poetry, and abuse, proved alike unavailing in permanently retarding the onward career of this great scheme; and the friends of the railway system found at length that success was rewarding their efforts. Public incredulity was modified; and the press aided the cause by the exposition of the advantages which would accrue from the establishment of railroads, and hastened to make known facts which, one after another, came to light, and were illustrative of the triumphs of the new means of locomotion.

Thus, so early as 1838, the proprietors of a Scottish periodical announced that, before their next number was published, in consequence of the sending of the mails to Warrington by the railway, the people of Edinburgh would receive their letters and papers an entire day sooner than during the time of the late war, namely, in thirty-one instead of fifty-five hours; and a return by post between London and Edinburgh, which, twenty years before, occupied a week, would then be accomplished in three days and a-half; and the *Railway Magazine* mentioned, as a prodigy of expedition, that a gentleman lately went from Manchester to Liverpool in the morning, and purchased a hundred and fifty tons of cotton, which he immediately took back with him to Manchester. He there sold the lot, and was offered a satisfactory price for another quantity. He at once returned to Liverpool, purchased the second lot, and delivered it the same evening.

Still, it was not without doubt that many of its friends regarded the ultimate establishment of a great system of locomotion on the new principle; and not a few apprehended that the spirit of enterprise which had prompted the undertaking of railway works, would gradually cool down. Private rights, it was said, must not be expected to yield easily, even in the certainty of great public advantages. Full compensation ought also to be given in every case where a private right was invaded. "But there ought to be a limit," it was well remarked, "to the power of prevention which private parties are thus invested with; care ought to be taken to distinguish between sound and frivolous opposition. Now, we are persuaded that very much of the opposition springs from the veriest fears and alarms, if not from worse causes still. For instance, one of the most useful of all the projected lines—that from Glasgow to Edinburgh—

was lately effectually opposed on various frivolous pretences, one of which was, that the locomotive engines, in passing through the Princes-street Gardens in Edinburgh (a deep valley in the middle of the town), would throw out sparks, and set fire to the powder-magazine on the top of the Castle—a building, let us remark, situated full four hundred feet above the level of the place, and described in Arnot's 'History of Edinburgh' as bomb-proof!"

But we must turn from objectors and objections, to observe the progress which was made in giving a practical test to the great scheme of railway enterprise. The lines which had been completed were increasingly rendered available by the public. Thus, we find that the Report of the Board of Trade for 1843 gives no fewer than 24,000,000 as the number of passengers for that year, the average distance travelled by each being about fifteen miles.

The lines which were sanctioned by Parliament during the year 1844, were brought forward partly from the advantages which their construction would offer to the towns connected together by them, and partly as measures of self-defence, adopted by established Companies to keep rivals out of their way. Thus, for instance, the extensions that were then projected by the South Eastern Railway in North Kent, and the branches and extensions of the Midland and Eastern Counties Companies, in the comparatively unoccupied districts between their routes to York and the eastern coasts of the island, were, to a great extent, plans of self-defence. So energetically were the steps taken, and so enterprising was the spirit of those connected with these lines, that at a meeting of the Midland Railway Company upon this subject, the proprietors voted *two millions and a half* of money to be applied, at the discretion of the Directors, to the formation of lines of which no definite plans were then decided on, but which were proposed to be: 1. From Nottingham to Newark and Lincoln; 2. From Swinton, by Doncaster, Bawtry, and Gainsborough, to Lincoln, and thence, passing near Boston, Spalding, and Wisbeach, to join the Eastern Counties at March; and, 3. From Syston, by way of Oakham and Stamford, to Peterborough.

Another class of projects, which occasioned considerable rivalry, consisted of branches or junctions, which were formed as connecting links between existing lines, but the precise course of which seriously affected the question as to which main line would attract the largest amount of traffic from the intermediate districts. Of this class were the various lines that were proposed between the South Western and Great Western Railways, those between the Great Western and the London and Birmingham, and several lines in

Yorkshire and the neighbouring counties. The new undertakings of various kinds, brought before the public during the year 1844, numbered no fewer than a hundred and fifty.

Early in the Session of 1844, a Select Committee of the House of Commons was appointed to consider the Standing Orders relating to railways, and also to examine the whole subject of railway legislation. In the performance of this work, the Committee recommended several modifications of the existing orders, which were adopted by the House. By these a reduction was made in the amount of deposit required by Parliament before introducing a railway bill, to one-twentieth of the amount of capital, instead of one-tenth, which had been demanded under the regulations of 1837; the expediency of the change being pleaded on the ground of the serious difficulty which the requirement of so large a deposit threw in the way of many useful schemes in times of commercial depression. Finding also, that so large a proportion of the bills before the House were for the construction of competing lines of railway, the Committee recommended the adoption of a new method of investigating their merits, by referring all such lines as might be considered as competitive to a Select Committee, consisting of members who should sign a declaration that their constituents had no local interest, and that they themselves were in no way personally involved in the bill or bills referred to them, and that they would not vote on any question that might arise, without having duly heard and attended to the evidence relating thereto. A Select Committee was also appointed, to consider which of the bills before Parliament should be deemed competing; and these, by looking at cases of remote competition, as well as to those of a more direct and indisputable character, brought the subject very fully and completely before Parliament.

The results of the labours of the Railway Committee were brought before the House in several subsequent Reports, upon which a bill was founded, some of the provisions of which, relating to third-class passengers, are worthy of passing notice. By these it is required that one train shall pass from one end to the other of every trunk, branch, or junction line, once at least each way on every week-day; the time at which these trains shall start being fixed by the Lords of the Committee of Privy Council for Trade and Plantations; that each train shall travel at an average rate of speed of not less than twelve miles an hour, including stoppages; that it shall take up and set down passengers at every passenger station on the line; that the carriages shall be protected from the weather, and provided with seats; that the fare shall not exceed one penny a mile; that half a hundred

weight of luggage shall be allowed to each passenger, any excess being charged by weight, at a rate not exceeding the lowest rate of charge for passengers' luggage by other trains. It is further enjoined, that children of three years old shall be conveyed without charge, and that, from that age up to twelve, the rate shall be one-half the amount of an adult passenger. A penalty is enforced of £20 a-day for the non-fulfilment of these conditions; but a discretionary power is allowed to the Board of Trade, of sanctioning alternative arrangements.

A remarkable feature of the railway history of the year 1845, is the number of amalgamations which were made between individual lines, and the arrangements of the principal Companies to lease the minor lines connected with their own undertakings. But there were a large number of cases which, after an agreement for such an union of interests had been made by the Directors, and sanctioned by a public meeting of proprietors, were "repudiated" at subsequent meetings, in consequence of a rise in the market value of the stock, or of the prospect of obtaining more favourable terms with another Company. Among these cases, the chief were the union into one body of the Grand Junction, Liverpool and Manchester, Bolton and Leigh, and Kenyon and Leigh Companies; the union of the Birmingham and Gloucester, and Bristol and Gloucester Companies, and subsequent leasing of the united line to the Midland Company; the leasing, by the York and North Midland Railway Company, of the Great North of England and Hull and Selby Railways; the union of the Manchester and Leeds Railway with the Manchester, Bolton and Bury; of the London and Birmingham with the Trent Valley, Manchester, and Birmingham; and, according to an arrangement, sanctioned by special meetings of both Companies, in November, 1845, with the Grand Junction Railway; the contemplated purchase of the Bristol and Exeter line, by the Great Western Company; and the amalgamation of the London and Brighton and London and Croydon Companies, in November, 1845.

But we are drawing near to a great epoch, not only in the history of the railway, but of the monetary world. In order clearly to understand the position of affairs, we must beg the reader to accompany us while we briefly review the commercial history of the railway system during the few years preceding the period at which we have arrived.

Up to the year 1843, and during part of 1844, railways may be regarded as honestly working their way through good and evil report into the public appreciation of their value, not only socially and generally, but as a means for the investment of capital. But evil had

begun to mix with the good; and the Report from the Select Committee on Joint Stock Companies, in 1844, announced many unwelcome truths. When a Company was to be formed, the prospectus was usually first issued, sometimes without the names of Directors, in the expectation that parties would form themselves into a direction for its support; and advertisements were issued of the new project. As soon as the scheme attracted attention, applications were made, in the hope that the shares would come out at a premium, however small. If that chance existed, then every species of influence was employed to get an allotment; and on this being received, the shares were disposed of for what they would bring; and such letters of allotment have been sold at the rate of threepence to twenty shillings a share. Mr. Duncan, M.P., stated, that most frequently the shares were not attended to at all, for the applications of persons were never made unless the result brought the certainty of an immediate premium, however trifling. "The reason," he said, "why these letters can be dealt in, is, because the Company's bankers, not knowing one from another, take money from everybody who brings a letter of appropriation, and they give a receipt. This receipt is taken to the Company's office and exchanged for a scrip certificate to bearer, and then the title of the buyer of the letter is complete. If there be much risk about the Company, or no great soundness, or if it be ill supported by the Directory, a second call can never be obtained. The consequence is, that after from six to twelve months' duration, the Company is dissolved, and dies a natural death, and the deposit is found to be eaten up by expenses. Another cause for dissolution after the first deposit is, that the scrip shares have got into hands resolved to pay nothing more; who laugh at the power of forfeiture in the Directors, and know that the power to sue for calls the Directors have not got, as no deed of settlement has yet been signed."

In the year 1843, twenty-four Railway Acts were passed, and in 1844, thirty-seven more obtained the legislative approval. The rapidity with which these projects were advanced, attracted the attention of Parliament, and an enactment was made, which provided that every person whose name appeared as a provisional committeeman, should hold a share or shares in the concern; and this clause rendered each of the class liable to the extent of his property. But scarcely had railways become a means of legitimate investment, than they were rendered available for a system of speculation, which far transgressed all the bounds of propriety, prudence, and right. Capitalists no longer hesitated to embark their millions in railway enterprises. The inhabitants of large towns felt, or fancied, that

without sharing in the new facilities of communication, their trade would decline in competition with that of their neighbours, and innumerable schemes were advanced. The press generally, and the railway press—a species of literature which was called into existence by the exigencies of the times—beheld with triumph a new power intrusted to it, and advanced in its course with vigour. Patriotism and poetry, paragraphs and pamphlets, essays and articles, aided in the work of exalting the value of railways.

"Railways," it was said, "are the wonder of the world. Nothing during the last few years has created so marvellous a change as the great iron revolution of science. Beneath it the features of old Christendom have become changed, and its wealth and physical grandeur augmented. Other revolutions have scattered luminous influences over the world, but it remained for the new generation of railways to bring about one of the mightiest moral and social revolutions that ever hallowed the annals of any age. Omnipresence is one of the principles of their progress. Not content with making Liverpool their lineage home, and many-sounded Manchester mistress of their choice, they are throwing a girdle round the globe itself. Far-off India woos them over its waters, and China listens to the voice of the charmer. The ruined hills and broken altars of old Greece will soon re-echo the whistle of the locomotive, or be converted to shrines sacred to commerce, by the power of those magnificent agencies by which rivers are spanned, territories traversed, commerce enfranchised, confederacies consolidated; by which the adamantine is made visible, and man assumes a lordship over time and space."

Such were the means employed for the furtherance of this great scheme, and everything which occurred was made subservient to the increase of the excitement. January of 1845 saw the registration of sixteen new lines; in February and March, this number was more than doubled, and in April, fifty-two additional Companies were formed. The popular enthusiasm had, in fact, altogether passed the bounds of discretion and right, and was hastening forwards in an unjustifiable and insane career.

Amidst a great number of *bonâ fide* undertakings, appeared a multitude of bubble projects, concocted by those who cared only to prey on the honesty or credulity of others. Out of a true spirit of legitimate enterprise arose a mania, in the midst of which many a needy rogue was transmuted into what society calls "a gentleman." The chief object was to gain possession of the deposit money, and to spend this in preliminary expenses, (*i.e.* their own,) and lawyers'

bills. The capital required for such an undertaking at the crisis referred to, was small. A few knaves engaged an office, bought a map, struck out a railway in what appeared to be a suitable direction, gave it a plausible title, and with a sheet of foolscap and a "Court Guide," they selected the names of a few noble lords, right honourables, ex-M.P.'s and merchants, made prospectuses, to which an engineer, banker, and lawyer were soon added, and "served up," with imaginary advantages, and the assurance of at least ten per cent. dividend. The excitement of the times prevented much chance of the detection of the fraud, and the inexperienced, who wished to speculate, mistook the base for the sterling. Shares were advertised at £2 or £2 10*s*. for the first instalment, only a certain number being allotted, that they might bring a full price, while "stags" were actively engaged in inquiring for shares which they never intended to purchase, and only asked for, to give them a fraudulent value in the market; or perhaps they bought a few with the deposit-money which subscribers had paid, in order to produce the same result. As soon as the sound of premium reached the ears of "the authorities," the whole quantity of shares was thrown into the market, and sold for what they would bring. The profits thus realized were, in many instances, enormous; cabs were set up, tigers were hired, and, *mirabile dictu!* good coats and clean shirts began to be worn by men who had been strangers to these luxuries for many a day.

The successes of both honest men and of knaves, in share-speculating, encouraged large numbers of both classes to embark in the enterprise, and the mania proportionately increased. The *Manchester Guardian* reported that during one week, eighty-nine new schemes had been announced in three newspapers, the capital required for which was estimated at more than 84 millions; while in the space of a month, three hundred and fifty-seven railway projects were advertised in the same journals, having an aggregate capital of 332 millions sterling.

> "Old men and young, the famish'd and the full,
> The rich and poor, widow, and wife, and maid,
> Master and servant — all, with one intent,
> Rushed on the paper scrip; their eager eyes
> Flashing a fierce unconquerable greed—
> Their hot palms itching — all their being fill'd
> With one desire."

Servants wrote for shares in their masters' names; and there is a story told of a butler at the West-end giving notice to his mistress to quit, as he had realized several thousand pounds by shares. On

the lady asking him how this was, "Why, ma'am," he said, "I applies for the shares, and gives a reference here; and, as I opens the door myself, and answers the reference, I always gives myself the wery highest character for property and all that, and so I gets the shares and sells them." And thus we have the living realization and prototype of *Jeames of Buckley-square*, renowned in song and story.

A voluminous return, subsequently made in conformity with an order of the House of Commons, sufficiently shows the universality of the interest of the public in railways. It includes the names of all who subscribed for *less* sums than £2000; and among them may be recognised many of the leading nobility, the largest manufacturing firms, and individuals well known from their connexion with various departments of science, literature, and art. The juxtaposition of the professions or engagements of some is very amusing. Side by side are "peers and printers, vicars and vice-admirals, spinsters and half-pays, M.P.'s and special pleaders, professors and cotton-spinners, gentlemen's cooks and Q.C.'s, attorneys' clerks and college scouts, writers at Lloyd's, relieving officers and excisemen, barristers and butchers, Catholic priests and coachmen, editors and engineers, dairy-men and dyers, braziers, bankers, beer-sellers, and butlers, domestic servants, footmen, and mail-guards; with a multitude of other callings unrecorded in the Book of Trades."

"Every man of the present day," said a facetious writer of the period, "is a holder of shares in a railway; that is, he has got some pieces of paper called scrip, entitling him to a certain proportionate part of a blue, red, or yellow line drawn across a map, and designated a railway. If the coloured scratch runs from south to north, it is generally called a Trunk-line; if it 'turns about and wheels about' in all directions, leading to nowhere on its own account, but interfering with every railway that does, ten to one but it is a Grand Junction; and if it lies at full length along the shore, it is a Coast Line. Trunk-lines are generally the best, because the word trunk naturally connects itself in the mind of the public with the idea of luggage, and a good deal of traffic is consequently relied upon. Grand Junctions are good speculations, as troublesome customers, likely to be bought off by larger concerns, which would consider them a nuisance; and as street nuisances generally expect a consideration for moving on, a Grand Junction may ask a good price for taking itself off from an old established Company."*

The localities of railway enterprise were curious. From Moor-

* Cruikshank's Table Book.

gate-street issued nearly ninety prospectuses of railways, the capital required for which amounted to as many millions sterling. In Gresham-street twenty were planned, requiring for their construction the sum of more than seventeen millions, and eight of them having originated in one house. Well might *Punch* say, "As many as seventeen thousand newspapers have been found in the General Post Office with their covers burst. The reason of the newspapers bursting is accounted for by the fact that they contain so many railway bubbles."

The "manufacture" of the managers and officers of Companies was in many cases on an equally wholesale system. Taking the list of the members forming the provisional direction of twenty-three Companies, one man was discovered who belonged to them all; two, each of whom figured on nineteen Companies; three, who had given their names to seventeen Companies; fourteen, who belonged to fourteen Companies; twenty-two, to ten; twenty-three, to eight; and twenty-nine, to seven. These twenty-three provisional committees divided among themselves 352,800 shares, at the rate of 2800 a-piece.

The Irish railways furnished even a more ample list of pluralist Directors; and it is asserted that there would be no difficulty in pointing out several who held office in no fewer than thirty railway directions. The same parties even appeared as the promoters of rival lines; and individuals have been the avowed patrons of three competing Companies at the same time. It is unnecessary to cite specific instances, though this could easily be done; and the fact is abundantly illustrative of the recklessness so characteristic of the times.

The names of gentlemen wholly unconnected with railways, and who would have utterly repudiated association with the men who advocated them, were unhesitatingly employed for the purpose of lending a supposititious countenance to bubble Companies. One line was declared to enjoy the patronage of four gentlemen who had been dead for several months; and ten others had no knowledge of the existence of the scheme till they saw it paraded before the public, avowedly under their own sanction. In another case, the three leading projectors of a very costly railway were notoriously "living by their wits," and could not have raised a hundred pounds among them, except by fraud. The course usually adopted when gentlemen protested against the unwarranted use of their names, was to assure them that it was quite a misunderstanding; and, after many apologies, its use was continued till the parties were threatened with public exposure.

Affairs went on in this manner for some time, all thinking men being aware that a crash must and would come before long. The

position of things was indeed ominous; and a local journal said, with great force, at the time, "But the prospect becomes more serious, when it is discovered in what feeble hands great masses of this speculation rest; in what manifold ways the mischief has descended through all classes of society; to how many persons a reverse will be utter ruin, not to themselves only, but to helpless numbers whom they have deceived, with whose funds they have been gaming, or to whom they owe debts that can neither be paid nor spared; with such a view before us, it is not merely the pain awakened by a single case of ruin and despair that affects us in the instance quoted above: we tremble to think how much more of the like vice and folly, now concealed under this surface of bustle and feverish excitement, may be at this moment struggling in the grasp of the same evils, and preparing other lamentable scenes of failure, shame, and madness. Nor is it for the useless object of provoking alarm that we express these apprehensions. It is with the practical, honest purpose of discouraging that which, whether successful or unlucky, is thoroughly foolish, and false, and vicious—the greedy pursuit of gain by unjustifiable means. This dishonesty every man commits who engages himself, in the hope of winning, in obligations which he cannot meet if the die falls on the losing hand. It is a vice which we fear is becoming an utter plague in the land—a pestilence destructive of things infinitely more precious than even the fortunes or maintenances which it rashly hazards. Every day brings us some new instance of its hateful effects upon private happiness and public character. Now, we are told of shameful disclosures affecting the honour of men in office,—persons whom it was our English boast, for the last half century at least, to proclaim to the world as above the suspicion of any foul handling of lucre. Now, we are called to deplore the utter ruin of a household, dashed down from decent competency into beggary and disgrace, in the frantic pursuit of sudden wealth. The next moment, we hear of a pious defaulter for hundreds of thousands; and, turning from him in disgust, we stumble on the body of a suicide!"

The sinews of war, once obtained, were quickly put into requisition to further the objects of the projectors of the line. It was on the deposits which thus came into their hands that Directors, without money themselves, counted to carry on the management. The Company, once so started, could prosecute its operations on a large scale. "Confidence, generosity, cash, were sure to command success. So crack engineers were engaged at large salaries, and received *carte blanche* for their surveys and surveying parties. Advertising agents were instructed to be active and liberal; they boasted of their in-

structions to editors and proprietors of newspapers. The newspapers puffed, and charged like heroes; the Directors and Secretaries bragged to the newspaper writers; surveyors composed epics on the capabilities of the lines; and shareholders listened to the lay, with the vague, swelling, dreamy day-light of opium-eaters under the influence of their drug. All concerned assumed that the nominal capitals of all the projected Companies would be actually forthcoming; all counted upon the share in the plunder which they had in imagination allotted to themselves, being as sure as if they had already held it in gold."

The follies and the frauds which had been enacted during the South Sea Bubble were rehearsed in this second mania; and the record of the one by its historian, may well be taken as descriptive of the madness and the guilt which were manifested in the other. "During the progress of this famous bubble," he says, "England presented a singular spectacle. The public mind was in a state of unwholesome fermentation. Men were no longer satisfied with the slow but sure gains of cautious industry. The hope of boundless wealth for the morrow, made them heedless and extravagant for to-day. A luxury till then unheard of was introduced, bringing in its train a corresponding laxity of morals. The overbearing insolence of ignorant men, who had arisen to sudden wealth by successful gambling, made men of true gentility of mind and manners blush that gold should have power to raise the unworthy in the scale of society. The haughtiness of some of these 'cyphering cits,' as they were termed by Sir Richard Steele, was remembered against them in the day of their adversity. In the parliamentary inquiry, many of the Directors suffered more for their insolence than for their peculation. One of them, who, in the full-blown pride of an ignorant rich man, had said that he would feed his horse upon gold, was reduced almost to bread and water for himself. Every haughty look, every overbearing speech, was set down, and repaid them a hundred-fold, in poverty and humiliation.

"Public meetings were held in every considerable town of the empire, at which petitions were adopted, praying the vengeance of the legislature upon the South Sea Directors, who by their fraudulent practices had brought the nation to the brink of ruin. Nobody seemed to imagine that the nation itself was as culpable as the South Sea Company. Nobody blamed the credulity and avarice of the people, the degrading lust of gain, which had swallowed up every nobler quality in the national character, or the infatuation which had made the multitude run with frantic eagerness into the net held out for them by scheming projectors. These things were never mentioned. The people were a simple, honest, hard-working people, ruined by a

gang of robbers, who were to be hanged, drawn, and quartered without mercy. This was the unanimous feeling of the country."

The "stags," who performed so important a part in the Railway Mania, should not go unnoticed. They are an unique race, though there are several grades of professional calling, each with its appropriate designation. A regular thoroughbred stag is perhaps some forty years old, or upwards, with a face wearing a peculiarly sinister expression, tainted with colours suggestive of strong drinks. His apparel is worthy of his vocation, but varies according to the circumstances of the case, or the occasion. Sometimes he disports a faded suit of black—then he appears in drab unmentionables and gaiters; but there is almost invariably a tint about his garments, which is only to be expressed by the word—*seedy*. Some individuals of the species have an appearance akin to that of those "sporting gents" who are to be found near the betting places on the course, and they all have a taste for sporting. They indulge in small transactions of this kind, and do not eschew skittles; and if a stag has his hand in his pocket, he is generally fumbling a greasy half-penny, which he calls into frequent requisition in order to decide, by tossing up, any disputed point, in reference to which his veracity may be called in question. This, however, is when he is in his easier moods. A writer who has sketched this interesting class,* thus describes the stag when professionally engaged:—"When sneaking into an office as a slate quarry proprietor, or great railway capitalist, he has a subdued air, and the clerk in his teens, and first experience of railway business, listens to his inquiries with becoming deference, and ushers him into the presence of the secretary, or sees him carefully lay up the letter of application in his enormous pocket-book, to which his multifarious memoranda are consigned, and which contains a list of all the applications he has under hand, entered systematically, with the several names and addresses made use of. The clerk little thinks that the bulk in his coat pocket consists of several enormous bundles of prospectuses, greasy outside, and bound up with red tape. It is needless to say, that the stag has long since been in the position of having no character to boast of, having gone through all the several stages of whitewashing, remand, and imprisonment in Whitecross-street, with perhaps some experience of the criminal jurisprudence of his country. He has a knowledge of business, for he has failed in it; and he is disinclined to begin again, as he is an uncertificated bankrupt. He hates work, and prefers misery. Where he lives no one knows. His letters are generally addressed to the Old Kent Road; but it is doubt-

* Railway Register. June, 1845.

ful whether he have any residence at all. His mornings begin by carefully examining all the daily papers at a pot-house or cheap coffee-house, where he makes copious memoranda of all the places to be called at for prospectuses and forms of application. He then gets his letters, and if he has the good luck to get any shares allotted, he proceeds to sell the latter among his brethren; and glad is he if he can take a few shillings home. Besides looking after prospectuses, he occasionally varies his pursuits by signing deeds, to make up the parliamentary subscription list. This he does for the consideration of, perhaps, five shillings per name,—going in, it may be, with a pair of spectacles on, and signing the deed, and then returning without the spectacles, and signing in some other capacity. A well-known hotel and tavern-keeper in Covent Garden is reputed to contract occasionally for supplying these vagabonds with such things, and with the carrying out schemes for plundering the small tradesmen, and other unfortunate individuals having money, who get dealings with them. The stag passes the day, to conclude it, if lucky enough, in the pot-house."

And here our history would be incomplete, were not some allusion made to the vast influence, and remarkable but changeful fortunes, of an individual whose name is indissolubly associated with this era in the annals of our railway system. George Hudson was born in 1800, and having served his apprenticeship in the ancient city of York, subsequently carried on business there as a linendraper, with such success as to amass considerable property. The gratifying results which had attended the opening and the working of the Liverpool and Manchester line, had attracted the attention of the country at large; and while various schemes of railways were proposed for different parts of the country, the people of York determined to have their schemes also. The formation of the Leeds and Selby line in their own vicinity augmented this desire; but when the arrangements were made, such were the difficulties which arose, that, though Mr. Hudson came forward with a liberal offer of support, it was found necessary to delay the appeal to parliament for the requisite powers.

Three years passed away, and when, in 1835, it was proposed to establish a line between York, Leeds, and London, Mr. Hudson was appointed one of the provisional committee, and subsequently, on the passing of the bill into law, he was made the chairman of the board. His personal efforts in this capacity were so great and satisfactory, that the cost of the land which he procured for the railway was only a little more than a third of the amount paid by the North Midland Company.

But past successes were only an incentive to fresh efforts. To avoid rivalry between his own and a neighbouring line, he proposed that it should be leased by themselves for thirty-one years; and not only was the plan approved and the contract made, but the result, in a pecuniary sense, was equally gratifying; other great schemes were undertaken, his most determined opponents shrank before him, and his plans were all approved. The shareholders of the North Midland were involved in great difficulty; he appeared before them, and in a remarkable speech advocated the possibility of the reduction of their expenses to nearly one-half; defended his statements with facts and figures, and offered to guarantee double the dividend the shareholders were receiving, if they would adopt his scheme of amendment. His speech had the intended effect; he was made chairman of a committee of shareholders, which led to the resignation of the Directors, and the appointment of Mr. Hudson as chairman of the North Midland Company. His plan of reform was vigorously carried out, the efficiency of the line was increased, the cost halved, and the shares gradually rose from £70 discount to £120 premium. Other great plans, on which we cannot enter, were successfully undertaken—embarrassed lines were relieved—weak ones were strengthened—rivals were subdued. Ever active, vigorous, and energetic, his capacity for business was singular; and it may without dispute be asserted, that up to a particular period of his history, his efforts were highly advantageous to the railways with which he was connected.

Nor did his efforts go unappreciated. Success sanctified all schemes, in the view of many, and for a time his name was heard everywhere, while the journals delighted to record his wonderful deeds. The highest and noblest in the land courted his favour; peers and peeresses were proud of the acquaintance of the energetic linendraper of York; the electors of Sunderland sent him to the House of Commons, where he was regarded as an oracle, and all classes of the community looked on him with feelings of admiration and wonder; for this was the man at whose magic touch everything seemed turned into gold.

But after a while the enthusiasm cooled, and the tables were turned. Mr. Hudson's connexion with the Eastern Counties Railway, and the truth that ultimately came to light, that dividends had been paid out of capital; the method in which it was found he had conducted the business of some other Companies; and the fact that many sustained fearful losses by the revelations which came to light, produced an entire change in the public mind in reference to their hero. But in the retrospect of all the circumstances of the

case, it is indisputable, that, whatever may be said of his proceedings, a large part of the invective poured out upon him came from quarters, of the purity of which there was little to boast. The fox that loses his tail is persecuted by all the foxes; the rook that is maimed is cawed out of the rookery. Mr. Hudson should be regarded as the type of the period in which he acted so prominently, —as the embodiment of the genius of that epoch in the history of manias. He had been held up to adulation because he had accumulated great wealth—his highest achievement, in the view of thousands, was the fact that he had made £100,000 in one day—and he was deified because he enabled others to be successful too. The subscription for a testimonial to him was made, not because he was a great or a good man, except so far as these qualities are ascribed to one who can accumulate wealth, but because he had grown rich in a hurry, and as one who had it in his power to help others to do the like.

"The truth is," said a writer in the *Illustrated London News*, "Mr. Hudson is neither better nor worse than the morality of 1845. He rose to wealth and importance at an immoral period; he was the creature of an immoral system; he was wafted into fortune upon the wave of a popular mania; he was elevated into the dictatorship of railway speculation in an unwholesome ferment of popular cupidity, pervading all ranks and conditions of men; and whatever may be the hue of the error he committed, it is rather too much to expect of him that he should be purer than his time or his associates. The commercial code of 1845 was, as far as railways were concerned, framed upon anything but moral principles. The lust of gain blinded the eyes of men who, before that period, could see clearly enough the difference between right and wrong, between trading and gambling, and between legitimate and illegitimate speculation. Men who would have scorned to do a dishonest act towards any other real tangible living man, did not scruple to do acts towards that great abstraction, the public, which no morality could justify. In the height of the railway mania it was generally admitted, that, ultimately, some parties must be losers; that the over-sanguine, or the cautious who came in last, would have to pay the piper for all the gains made by those who came in early; but, as nobody knew who these individuals were, nobody cared about them, or scrupled to make an immoral profit out of them. Mr. Hudson, from the superior magnitude of his transactions, from his superior talent in railway business, and perhaps, also, from his superior luck, became the representative of that system."

The Heraclitus of modern literature, in estimating the benefits which Mr. Hudson has conferred upon railways, has thus spoken: "For all manner of reasons, how much could one have wished that the making of our British railways had gone on with deliberation; that these great works had made themselves, not in five years, but in fifty and five! Hudson's 'worth' to railways, I think, will mainly resolve itself into this: that he carried them to completion within the former short limit of time; that he got them made in extremely proper directions, I am told, and surely with endless confusion to the innumerable passive Joplins, and likewise to the numerous active scripholders—a wide-spread class, once rich, now coinless—hastily in five years, not deliberately in fifty-five. His worth to railways! His *worth*, I take it, to English railways, much more to English men, will turn out to be extremely inconsiderable—to be incalculable damage, rather! Foolish railway people gave him two millions, and thought it not enough without a statue to boot. But Fact thought, and is now audibly saying, far otherwise! Rhadamanthus, had you been able to consult him, would in no wise have given this man twenty-five thousand pounds for a statue. What if Rhadamanthus had doomed him, rather, let us say, to ride in express-trains, nowhither, for twenty-five æons, or to hang in heaven as a locomotive constellation, and be a sign for ever!"*

But another epoch in the history of the railway system was advancing. Parliament having required that plans of proposed railways should be deposited at the offices of the Board of Trade, on or before Sunday night, the 30th of November, 1845, extraordinary efforts were necessary on the part of the Directors of numerous railways, to prepare their documents for that occasion; while the supply of labour in every department being greatly exceeded by the demand, its value proportionately augmented. Surveyors and levellers were required in all directions, and in many instances made from six to fifteen guineas a-day; while numbers of persons were employed who were acquainted with only the rudiments of the art, and who, by their blunders, subsequently occasioned great, and even fatal inconvenience to the engineers. The temptation of extravagant payment that was offered, induced great numbers to leave situations which they occupied, and to learn the business, while professors, lecturers, and teachers announced classes, lectures, and private instruction, which should convert all persons of ordinary powers into practical men, with almost magical celerity. Still the supply was not equal to the wants of the case, and surveyors and levellers became "worth their

* Latter-day Pamphlets. Hudson's Statue.

weight in gold." The circumstances connected with the employment of many of them are sufficiently amusing. A peddling stationer, who long itinerated in Northumberland and Durham, earned "five guineas a-day and his expenses" on a southern railroad; and in the *Lancaster Guardian* it was stated, that a fat neighbour, long unemployed, obtained an engagement of three guineas. "I could have had five," said he, "but in a country where the gradients were severe, and too trying for my wind;" and he, in consequence, preferred three guineas and a level line. As a circumstance indicative of the number of surveyors required on the various lines then designed, it may be mentioned, that no fewer than eighty arrived in Lancaster in one day, for the York and Lancaster line only, and they were followed by another "batch" a few days afterwards. During the month of November, scarcely a copperplate could be obtained, all the large houses having received as many orders as they could complete; and not unfrequently the money was paid in advance, to secure their execution. As the number of copies required from the plates was comparatively few, zinc was employed to a great extent, and even this was procured with difficulty at about double its usual price. Copperplate engravers were engaged in all directions, assistants were procured from all parts of the country; and, during the last week, some of the most eminent engravers did not consider it beneath them to aid in the work. Lithographic and zincographic draughtsmen were also collected from all the large towns in England, and many from France and Germany, who made their own terms with their employers. Prices rose with the demand, and at last almost any sum was paid to those who would undertake to execute the work.

During the last few days of November, engravers and printers laboured night and day; but in many instances, only the outlines of the plans were engraved, the sections being then drawn, or tracings were deposited with the plans, and the figures filled in by hand. In this way, other parties could be employed, and most of the engineers had from twenty to a hundred assistants thus engaged. Rooms at various hotels were frequently the scene of their labours; and as the work approached completion, many had not been in bed for a week.

On the 29th and 30th of November, the work of depositing the plans remained to be accomplished by many different Companies in all parts of the country. By some strange oversight of the authorities, the Sabbath had been made the last day on which the documents could be deposited at the offices of the Board; and the excitement, business, and bustle on that occasion, were in entire discordance with

the proprieties of society, and the requirements of Christianity. On both the Saturday and Sunday extraordinary efforts were made to fulfil the important commission, for the majority of the papers had to be transmitted from the provinces. The opponents of the lines were also equally on the alert, and a variety of tricks were resorted to by many to frustrate the designs of the projectors. Some of the Companies on whose lines express trains had been ordered for the conveyance of the plans, and who felt that their own interests were in danger from the projected lines, interposed almost every conceivable obstacle, and one of them ultimately refused to convey the required documents to London. The friends of the new rival, however, were not to be thus out-generalled, and resorted, for the accomplishment of their object, to a rather original *ruse*. On receiving a peremptory denial to their demand for the means of transport, the promoters of the competing line hired an *undertaker's hearse*, and having placed the plans, sections, and clerks inside, they conveyed it to the station, and it was unhesitatingly forwarded with its contents to the metropolis. Six special trains had been ordered on the Great Western line for nearly the same hour, for each of which, it is said, £80 were paid.

Various other illustrations of "sharp practice" were furnished on this occasion. Horses had been engaged at one of the principal hotels by the promoters of the Dudley, Neadely, and Trowbridge line, to convey their papers to Stafford. The cattle had been kept in the stable during four days, in order that they might be thoroughly refreshed for their journey; but on being "turned out" at the required time, they did not progress at a greater rate than four miles an hour! The attorney in charge, having failed to produce any effect on the postboys, by request, demand, and intimidation, came to the conclusion that they had received a handsome consideration from the opponents of the line; and finding that other means must be resorted to if he expected to arrive at the place of his destination within the required period, he leaped from the carriage, detached the traces, and thrashed the postboys till they roared for mercy; he then resumed his seat in the vehicle, and the remainder of the stage was performed at the speed of fifteen miles an hour. Nor was this a solitary instance of the determination required, and the fertility of resource exhibited, on the part of the friends of the proposed lines, in the fulfilment of their important commissions.

In the year 1844, the number of projects, in respect of which plans were lodged with the Board of Trade, was 248; the number in

1845 had increased to 815. The projectors of most of the Scottish lines, with characteristic prudence, lodged their plans on Saturday. The Irish projectors, and the old-established Companies seeking powers to construct branches, were among the more punctual; but upwards of six hundred plans remained to be deposited on the Sabbath. The excitement attendant on such an undertaking was extraordinary; and as the hours rolled away, and the allotted period was drawing to a close, the feeling increased to a painful intensity. As the last hour of the Sabbath drew near, the scene at the offices of the Board of Trade was animated in the highest degree. A large establishment of clerks was in attendance, to go through the necessary formalities, and this arrangement proceeded very well till eleven o'clock, when the delivery increased so rapidly, that the officials were quite unable to keep pace with the arrivals, and still vehicles of all sorts and sizes dashed up in breathless haste, and discharged their contents of documents and projectors. The entrance-hall was crowded, and as the allotted period was gliding away, the expression of anxiety on the countenances of those assembled, indicated their apprehension that, after all their efforts, they should be unable to complete the required arrangements within the very limited time that remained. Eager inquiries were made, and speculations offered on the probabilities of those who arrived with their plans before the hour had elapsed, being allowed to complete the business afterwards; and their countenances brightened when they were assured that this privilege would be granted. As the clock struck twelve, the doors of the office were about to be closed, when a gentleman with the plans of one of the Surrey railways arrived, and with the greatest difficulty succeeded in obtaining admission.

Despite all their efforts, however, some were unsuccessful. "The witching hour of night, when churchyards yawn and graves stand tenantless," never seemed half so terrible to the rustic as it did to the unfortunate wights who were hastening to the offices of the Board of Trade, and failed to reach it when "the iron tongue of midnight" smote upon their ear, and told them that the 30th of November, 1845, had passed away for ever. A lull of a few minutes now occurred in the hall of the Board; but just before the expiration of the first quarter of an hour, a post-chaise with reeking horses drove up in hot haste to the entrance. Three gentlemen who were its occupants immediately alighted, and rushed down the passage leading to the office-door, each bearing a plan of huge dimensions. On reaching it, and finding it closed, the countenances of all drooped; but one of them, more valorous than the rest, and

prompted by the by-standers, gave a loud pull at the bell. It was answered by Inspector Otway, who informed the ringer that it was now too late, and that his plans could not be received. The agents did not wait for the conclusion of the unpleasant communication, but, taking advantage of the open door, threw in the papers, which broke the passage-lamp in their fall. They were, however, soon tossed back into the street, and again into the office; and this "was kept up for nearly half an hour, to the great amusement of the crowd." The projectors, however, were unsuccessful, and were ultimately obliged to retire, to their no small discomfiture.

The statistics of railways at this time show the wholesale way in which great schemes had been undertaken, without any idea of the value to accrue, or of the resources from which they were to be carried out. We find that in November, 1845, the enormous number of 1428 lines were either made, or authorised to be made, or announced to the public, and registered. The vastness of this aggregate will be seen by comparison with the lines which had been at that time completed, or were then in progress. Including the session of 1845, there had been passed rather more than four hundred Railway Acts, relating to about two hundred and fifty lines, some of which had not been completed. Taking the estimates in round numbers, we find that of these nearly a hundred new lines were authorised during the preceding session, which was three times as many as in any one session before. Only forty-seven lines were actually completed from 1823 to the end of 1844. Passing next to the cost of these railways, the aggregate sum which Parliament had empowered Companies to raise, whether as capital or by loan, was £154,716,937, including the earlier and ruder descriptions of railways constructed for the carriage of coals and ore, from 1801 to 1825. It also includes the relinquished lines. The forty-seven lines completed from 1823 to the end of 1844, cost £70,680,877. The number of railways then in progress was 118, their aggregate mileage 3543, and their estimated cost, or at least the whole sum which they had obtained authority to raise, was £67,359,325. By adding, therefore, to the actual cost of all the completed lines the estimated cost of all lines then in progress, we arrive at the aggregate capital of the railway undertakings of the country as it then stood, amounting to £138,040,202. Of the projected lines there were 1428, with an estimated capital of £701,243,208, and a deposit of £49,592,816. One of the items was £40,000,000, for one scheme.

The cost of the railway mania was enormous. Utterly worthless and fraudulent as were many schemes, they involved as much

preliminary expense as if they had been substantially good. Offices, agents, lawyers, engineers of every class, advertising and meetings to puff, were not then to be obtained at any reasonable outlay. It is computed, on high authority, that on the aggregate estimated capital at least one per cent. would be required for the above-mentioned purposes—a sum as much lost as if fifty first-rate line-of-battle ships had been sunk to the bottom as soon as launched,—as if two million quarters of wheat had been thrown into the sea,—as if a conflagration in the metropolis had consumed 10,000 average-sized houses. The item of advertisements alone will serve as an illustration. "We will answer for it," said a competent writer, "that during the two or three months immediately preceding the late salutary check, as much as a hundred thousand pounds a week were spent in railroad advertisements." This statement was made on November 8, 1845, and the advertising still continued.

But "a change" now "came o'er the spirit" of railway enterprise. Thousands had bought stock in the hope of realising profit by the speculation, but, having no intention of permanent investment therein, were now anxious to back out of the concerns with which they were identified. The projectors of bubble Companies, too, were obliged to meet the shareholders, and in the most gentlemanly terms to intimate their deliberate and conscientious conviction, that though some eighty or a hundred thousand pounds had been expended, yet that, on the whole, it would scarcely be expedient to proceed with the line. Many holders of shares having discovered the manner and extent to which they had been duped, threatened exposure and the terrors of the law, and were rewarded for their trouble by the discovery, that the batch of projectors were not worth punishing; or, before they had commenced legal proceedings, by seeing their "acquaintances" snugly reading the newspaper on board a Boulogne or Ostend steam-packet, where they were going to enjoy their ill-gotten plunder. The utter worthlessness of many of the schemes now appeared, and it was found that there was a striking likeness between angling and railway speculation, for that—

"A hook 's the end of many a line."

The anxiety and excitement among the holders of railway scrip shares, were such as it is difficult adequately to conceive. To sell scrip connected with new lines was almost impossible, even at any sacrifice, and the only relief which great numbers of holders looked to was, that the bills would be thrown out by Parliament, and that some unappropriated funds would remain. This feeling existed even

with respect to those lines which a few months before were regarded as the most promising; and it was affirmed at the time, by competent authority, that probably there was at one time not a single new Company, in which the majority of the shareholders would not have voted for an abandonment. Hence, the most doubtful schemes were regarded by many as the most advantageous to holders, for in these it was seen that the limit of loss would be least, as the Parliamentary Committee would strangle them in the birth.

Pay-day came at last, and, as every thinking man had seen was inevitable, there was not enough for all, and disappointment and misery was the reward of thousands. And while those who had not so fully participated in the gigantic system of delusion which had been suffered to enjoy this brief existence, found themselves penniless, those who had been most active in its promotion, and had tried to move heaven and earth in the carrying out of their projects, were equally smitten down in the crash. Well was it said, in imitation of the well-known words of the poets:—

"Oh! many a stag, late blithe and brave,
Forlorn 'mounts the ocean wave;' *
And many a 'letter' has been torn,†
And countless scrip to trunks been borne;
And many an antler'd head lies low,
Which whilom made a glorious show!
And many a fast coach now 'crawls' slow!"

The process of "breaking up" manifested itself in a variety of ways, according to the circumstances of the case, or the temperament of the individuals affected,—illustrating the real nature of the mania by its "consequential sorrows." "Internal dissensions," said a writer in *Tait's Magazine*, "are breaking out among Directors and their coadjutors, hurrying them before mayors and bailies, preparatory to more regular campaigns in the courts of law." Newspapers sent in their bills for advertising, pressing for payment, and boards audited these bills, calling for vouchers, and quarrelling with rates of charge. Operative surveyors were clamorous for wages, and secretaries for overdue salaries. Parties to whom scrip was allotted refused to pay deposits for what they then regarded as an unsuccessful

* "Say, mounts he the ocean wave, banish'd forlorn,
Like a limb from his country cast bleeding and torn?"
Campbell's Lochiel.

† "And many a banner shall be torn,
And many a knight to earth be borne;
And many a sheaf of arrows spent,
Ere Scotland's king shall pass the Trent.
Scott's Marmion.

concern; boards, to accelerate the payment of deposits, reduced the amount of their calls; while impatient holders, who were precipitate in paying up, asked to have the excess refunded,—which, out of an empty treasury, was rather difficult. Out of tart remarks and bitter rejoinders, come decided acts. "One angry man goes with quiet, concentrated malice, at white heat, to consult his lawyer; another rushes, roaring like a boy that has been soundly thrashed, into a mayor's court, to tell his 'pitiful story.' The newspapers, as usual, blow the coals, for every 'excitement' promotes sale. The public mutters, 'Try the responsibilities of Directors in a law court;' and deeply-staked Directors respond to the hint, by advertising a Defensive Association. The genius of Westminster-hall laughs, crows, and claps its wings: nay, it did so months ago. In July, The *Law Magazine* coolly discussed the various points likely to arise when this crisis came: the hoodie crows croaked their consultations anent picking bones, in the ears of their unheeding victims."

A parody which appeared about this time, described the position of affairs with great accuracy.*

"There was a sound that ceased not day or night,
Of speculation. London gathered then
Unwonted crowds, and, moved by promise bright,
To Capel-court rushed women, boys, and men,
All seeking railway shares and scrip; and when
The market rose, how many a lad could tell,
With joyous glance, and eyes that spake again,
'T was e'en more lucrative than marrying well;—
When, hark! that warning voice strikes like a rising knell.

"Nay, it is nothing, empty as the wind,
But a 'bear' whisper down Throgmorton-street;
Wild enterprise shall still be unconfined;
No rest for us, when rising premiums greet
The morn, to pour their treasures at our feet;
When, hark! that solemn sound is heard once more,
The gathering 'bears' its echoes yet repeat—
'T, is but too true, is now the general roar,
The Bank has raised her rate, as she has done before.

"And then and there were hurryings to and fro,
And anxious thoughts, and signs of sad distress,
Faces all pale, that but an hour ago
Smiled at the thoughts of their own craftiness.
And there were sudden partings, such as press
The coin from hungry pockets—mutual sighs
Of brokers and their clients. Who can guess
How many a stag already panting flies,
When upon times so bright such awful panics rise?"

* "There was a sound of revelry by night."
Childe Harold.

Scarcely had these disasters occurred than the mercantile world received several severe shocks. Commercial men who had raised the value of money by speculating in shares, were compelled to sell their railway stock for anything it would make; while others, rather than incur so great a loss, were glad to pay ten and fifteen per cent. interest for money. This tended greatly to increase the depression of the share-market: times did not improve—the pressure on the money-market was prolonged and augmented—and one convulsion after another shook the delicate fabric of commercial credit, and involved hundreds in ruin.

In looking back on the history of the Railway Mania, we have a remarkable illustration of the great truth, that "he that getteth riches, and not by right, shall leave them," or they him, "in the midst of his days, and in the end shall be a fool." And in an age like the present, when there is so strong a tendency to worship gold, we may well pause to ponder the lesson, and to give to it a personal and practical application.

Time rolled on, and gradually the first railway panic subsided. The apprehensions of many were found to be unreasonable; and though much fraud had characterised railway speculation, there was still much substantial good. Railway managers gave the best appearance to the Companies with which they were severally connected, confidence was in a great measure restored, and railway works began to be prosecuted with vigour. Trunk lines guaranteed six, eight, and ten per cent. to the shareholders of branches and extensions which were feared as rivals, but courted as *feeders*, while in reality they ultimately proved to be *suckers*. People wondered, but they did not distrust; shares continued at a premium; satisfactory dividends were declared; and the railway world went on in comfort and fancied security.

But ere long it was found, that, though large sums were divided among shareholders in the form of dividends, calls were frequently threefold as great; that the ten pounds received on a share had not seldom to be returned, with twenty in addition as a call, in order to carry on the work of construction or amalgamation. These, occurring from time to time, at last aroused the suspicion that all was not right, and vague impressions arose, which it has since been proved were correct, that the glittering dividends were in not a few cases paid out of capital, while the expenses of railway management were too great to allow of even moderate dividends, without a change of system.

The position of railways was at this time thoroughly unsatisfac-

tory. A good deal was known that was very questionable as regarded the soundness of railway property; and a great deal was hidden from view which people thought ought to be laid open to the public. Railway statisticians made their calculations, and the result was, dissatisfaction. It was believed that by the longest and in every respect the best lines, a profit of not more than three and a half or four per cent. was actually realized, or ought to have been paid, yet they were represented as sharing dividends of seven or eight per cent. It had been usual to estimate the working expenses at from thirty to forty per cent. of the revenue; but experience had proved that not less than one-half of all the money drawn for traffic was in most cases required to pay for the working of the lines. Now, whether the results which were given were authentic or not, it was almost impossible to say, since the Directors of the great lines, on which there was the most productive traffic, had not kept to their proper business of working their own lines, but had entered into heavy engagements, in guaranteeing high rates of interest to the proprietors of adjoining small lines, or had spent capital in making branches. It has, indeed, been declared, that the fundamental error in railway enterprise was the purchasing and leasing of insignificant lines at prices unwarranted by prospective profits, in consequence of which the bulk of the money advanced was dissipated and lost,—a result, however, not at all singular in commerce, in which men are every day seen to squander the profits of one good speculation on a hundred which afford no substantial return for either trouble or outlay.

These circumstances naturally occasioned no small anxiety among those who held property in railways. According to a statement that appeared in the *Times*, the traffic on some of the leading lines, with that on their projected branches, was greatly below what was inferred by the dividends that were paid. For example, it was declared, that in order to pay seven per cent., the London and North Western would require to draw for weekly traffic £70,000, while the average had hitherto been only £44,000. In the same way the Great Western required to draw £52,703; but the average was only £20,269. The London and South Western required £27,893; but the average was only £8899. Whether, on the opening of the connecting branch lines of these railways, the traffic would rise to the sums respectively indicated, was seen to be extremely doubtful. In the absence of data, the indecision which existed on these points was very painful. What, however, was the alternative? "Are we to believe," it was said, "that the respectable body of men constituting the Directors of the leading Railway Companies—men generally standing at the head

of commerce in their respective localities,—are practising a fraud on the country, or are themselves deceived from an ignorance of accounts? Until evidence more conclusive is produced, we must suspend our judgment on a matter so delicate, and repeat that it is incumbent on the Directories in question to relieve public inquietude by an intelligible statement of their affairs. To stand aloof, and resist the importunity for disclosure, on the ground that the public has no proper right to pry into private affairs, will only aggravate the evil." It was even alleged by some that the alarm had originated in a wish on the part of the Directors to depreciate their own stock, in order to buy in while shares were low; thus giving an additional coloring of fraud to the affair.

The result of such a condition of things was inevitable—shares sank in an extraordinary degree, and no one could tell where the depreciation would stop. And where was the remedy for the evil? It was at once to cease making calls, to stop the works as speedily as possible, or proceed to no more than were seen to be profitable. "Confine the total amount of calls," said a writer in one of the railway journals, "during the whole of the next year, 1849, to £6,000,000; that sum will be ample to finish lines nearly completed, and to open them for traffic. Reduce the rate of interest on loans to four per cent.; that is, not to borrow money in future at a higher rate than four per cent. per annum, and there will be plenty of money to do what is requisite." Besides this, a publication of the accounts of the Companies was indispensable. The "balance-sheet of a railway Company," said the *Times*, "has now no more effect than a sheet of waste paper; and as it would be perfectly easy to give accounts that would make everything clear, and these accounts are not given, it is naturally inferred that the market would not be benefited by the prospect they would indicate; and hence, that, although the end cannot be known, there is a certainty, at all events, that it has not yet been reached. If there is a single Company that is considered by its Directors to have fallen too low in the market, they can set the matter right. There are plenty of shrewd people at this moment, notwithstanding the hardness of the times, waiting with money in their pockets to find investments. Give them a statement such as they would require, and such as any City accountant, with the materials at his command, would prepare in a form that the simplest tradesman might understand it, and forthwith they will bid within a fraction of the true value of the shares."

At length the Companies also were impressed with the truthfulness and importance of these statements, and several were ultimately led

to publish their accounts, which showed their real condition to be in some respects better than had been believed; and by their promises of limiting their calls for the future, and their announcements on other points, they ultimately succeeded in allaying the popular fears, and stock went up in the market.

But while tracing the rise and establishment of our railway system, there is another—a contemporaneous history—which must not pass unnoticed. Horseflesh *versus* Steam had been the struggle, and the verdict of the country being for the defendant, a great locomotive system which had filled the civilized world with admiration for its completeness and efficiency, was set aside, and surperseded by one still more successful. But life to the one was death to the other. And in reading the decline and fall of our old coaching system, we would not let it go altogether away

"Unwept, unhonour'd, and unsung,"

to the unrecorded past. Mighty were its effects for good, and admirably were its capacities adapted to prepare the country for that better system of which it may be regarded as the forerunner.

The sentiments with which the railroad system was regarded by those interested in coaches were such as might naturally be expected to prevail. There were not many who were connected with the one that could adapt themselves to the other. A few, indeed, there were; and Mr. Chaplin, who had been one of the largest coach proprietors in the kingdom, and who, with his partners, before the opening of the London and North Western Railway, was owner of sixty-four coaches, and a thousand and five hundred horses, and whose annual return from this business produced upwards of £500,000, turned his property and abilities into the new system, and is one of the first railway carriers of the present day.

CHAPTER IV.

How to Commence a Railway—Selling an Idea—Provisional Direction—*Reconnaissance* of the Route of the projected Line—The Prospectus—The Capitalist's Breakfast-table—Capabilities of the New Project—The Subscribers' Agreement—Route of the Line determined—Considerations to be regarded—Surveying and Levelling—Opposition to Surveyors from Proprietors—Opposition to the Survey for the London and Birmingham Line—Plan to outwit a Clergyman—Affray at Glenfallach—Conflict on the Estate of Sir W. Milner—Determined Struggle on Lord Harborough's Property, near Stapleford Park—Regulation for the Deposit of Copies of the Surveys—"Fighting for the Act"—Legislative Interference in Railways Considered—Extraordinary Powers granted to Railways—Proposal for the Construction of Lines by Government—Parliamentary Committees on Railways—Excitement during "the Railway Session"—Scenes at and near the Committee Rooms—Profits of Counsel—Witnesses—Delights of a Railway Witness—Forensic Abilities of Engineers illustrated—Arguments *pro* and *con.* the line—Evidence of Witnesses—Scene in the Committee Room—Speeches of Counsel—Studies of Elocution—Efforts "out of doors"—Buying off Opposition—Illustrations—Amounts paid to remove Opposition from Interested Parties—Exceptions—Mr. Labouchere—Cost of purchasing Land, and Compensation—Purchasing an Editor—Parliamentary Evidence—Blue Books—Scene on the Announcement of the Decision of the Committee—Authority conferred by the Act—Supervision of the Board of Trade—Preliminary Cost of Railways—Solicitors' Bills—Enormous Waste of Capital in the Prosecution of the Preliminaries of Railway Construction—Total Cost of Railways.

AFTER it has been resolved to construct a railway in a particular district, the scheme must in the first place receive the support of persons competent to promote the undertaking. In some instances the proposal has originated with an individual who has received a handsome consideration in the form of "project-money" for his idea, from those to whom it has been communicated. In the early stage of proceedings the Directors are generally self-appointed, and they should be men of business-habits and local importance, that they may be able to influence members of the Legislature in favour of the project, and to conciliate those who are inclined to offer resistance to its prosecution. After a few meetings have been held for the general arrangement of affairs, a secretary, engineer, banker, and solicitor are selected, if they have not already been appointed; and sub-committees are provided for the regulation of the surveying, the share-

list, the expenditure, and the bringing of the matter before the public. The various requirements of law must also be observed; for, previous to the publication of the prospectus of a railway scheme, its advocates must transmit to the Registrar of Joint-Stock Companies the title of the proposed Company, its business, and the names and occupations of its promoters; and, either before or after the prospectus is published, they must state their provisional place of business, and the names and written consent of the committee-men to act in that capacity. In the mean time, the direction of the proposed railway is determined. For this purpose, the engineer makes a general *reconnaissance* of the country, and, aided by the Ordnance map, he acquaints himself with the nature both of the surface and of the formation of the intervening districts, with their canals, rivers, streams, and roads. By these means he is enabled to select the route which appears on the whole to present the greatest advantages, as affording the highest probability of substantial traffic; and which, with the least deviation from a straight line, avoids, as far as possible, all inequalities of surface, and requires the construction of the smallest number of artificial works. General arrangements having been thus completed, it is necessary to bring the subject before the world, in order that the "wherewithal" for the prosecution of the scheme may be provided. A prospectus is accordingly inserted in the principal daily and local newspapers, in which "an enlightened and discriminating public" is informed of the vast and benevolent project which has been devised for their advantage. In due time a newspaper reaches the breakfast-table of the capitalist, who, seated before the fire, toasts his morocco slippers as if they were "two abstemious thin slices of one French roll," unfolds the packet, still as wet and damp as the ague sheets of a German bed. His eye glances over subjects dramatical, political, poetical, and paragraphical,—now he pounces on this piece, and then flutters off to that; and after running up one column and down another, like an aide-de-camp on a battle-field, disregarding the accomplishments of nurse-maids, or the number of housemaids who want situations "where a footman is kept;" wondering, for an instant, how a gentleman, no more than fifty, who possesses, according to his own candid confession, to have "all the virtues out of heaven," and five hundred a-year to boot, should be reduced to the unpleasant necessity of advertising for a wife; and meditating for an instant on a variety of other equally important considerations, the long-wished for prospectus of "the Grand Diddlesex Junction," of which he has already heard, attracts his enraptured gaze. Therein he reads that a "direct, cheap, and

convenient railroad" is to be constructed through a populous and wealthy district, situated in a county or in counties whose manufacturing, mining, agricultural, trading, or commercial resources are minutely and vividly delineated. The document expatiates on the inconveniences which are at present experienced from the inadequacy of the means of communication; and the assurance is insinuated to all in whose neighbourhood the line will pass, that it will be a boon to trade, and will revive or augment all its commercial interests. It is then duly set forth that the value of the land is either "moderate," or a comparatively "trifling" item; that the whole line, with all necessary appendages, may be completed at an expense of so many hundreds of thousands sterling; that the annual return on the traffic arising from the conveyance of passengers and goods will yield, at very moderate rates of tonnage, an income to be divided amongst the subscribers "of at least ten per cent. per annum on their capital," after payment of all charges for making the line and keeping it in repair. The period is added at which the Act of Parliament will be applied for, in order to incorporate the subscribers as a Company, with all usual and necessary powers for carrying out the proposed scheme, and for the proper conduct and regulation of its affairs. The time and place at which the annual general meeting will be held; the number and value of the shares to be raised; the bank into which the money is to be paid; and an invitation to all persons who wish to take shares, to apply to the chairman of the Provisional Committee, usually conclude the paragraph; the assurance being added, that the present defective nature and the expense of the means of communication between districts so important, which "have been so often and loudly complained of," render unnecessary any vindication or apology for the present undertaking from its promoters. The logic and eloquence of the prospectus overcome the reader, and before his last cup of lukewarm coffee is swallowed, he resolves within his calculating bosom to write, without delay, to the Provisional Committee of the "Grand Diddlesex Junction," and to request, in accordance with the prescribed "form of application" which was subjoined to the prospectus, that there may be "apportioned" to him "shares in the above proposed railway;" and he engages to pay "the deposit of £2 10*s*. per share upon such allotment," and to sign its subscription contract required by Parliament, and also the subscribers' agreement. The nature of the subscribers' agreement, which not more than one in a hundred, or perhaps a thousand, of those who sign this instrument ever read, will be best seen by giving it to our readers. It is an agreement

between the Directors or Provisional Committee and the shareholders, and it will be found substantially as follows. It provides:—

"That the Directors or Provisional Committee shall be empowered, if they see fit, to invest such profits in any of the Government or other public funds, or in the purchase of Exchequer Bills. That the Directors or Provisional Committee shall be accountable for all income or profits which may arise from such investment or purchase, but shall not be answerable for any loss, if any such shall be occasioned thereby. And lastly, they, the said several persons parties hereto, respectively do hereby severally, for themselves and for their several and respective executors, administrators, and assigns, undertake and agree to and with the said A. B., C. D., E. F. (and so on), that, in the event of such Act or Acts not being passed into a law, each of them, the said parties, severally and respectively, shall and will well and truly bear, pay, allow, and discharge the expenses already incurred, or hereafter to be incurred, relative to the surveys and estimates for the said railway or branches, solicitors' and counsels' fees, travelling expenses, and all other costs and charges of every description incident to the proposed undertaking, and to the application or applications to Parliament: such expenses costs, and charges to be computed and assessed rateably upon the amount of shares or sums subscribed by each of the said several persons parties to these presents, and to a certain other agreement or instrument in writing (the preliminary or subscription contract), bearing date herewith, and to the like purport or effect. As witness our hands," &c., &c.

With the deposit money thus obtained, preparations are at once commenced for gaining the sanction of the Legislature to the proposed Company. Prior to this, it is necessary that the route of the line should be definitely fixed, and that plans and sections for the inspection of the Parliamentary Committee should be prepared. The selection of the course of the railway requires an intimate acquaintance with the country through which it is to pass, and the exercise of a sound discretion; for when once determined, it cannot be materially altered; and it remains a monument before the world, either of the ability or the incapacity of the engineer. Numerous, too, are the considerations which have to be regarded. The relative importance of various towns and villages which lie in the direction of the railway, and the traffic which may be anticipated to arise from them; the character and resources of the district, whether agricultural, commercial, or manufacturing; the number and nature of the population, and other statistical intelligence, must be collected from the best authorities. And on what principle, it may here be asked,

shall the route be decided? Take the map. There are the termini, and there are the intermediate towns. And what of these "intermediates?" Nothing, it is replied by some. Select your termini, say they, and then, according to every dictate of sound policy and of science, run your line between them, as straight as possible. It is not even necessary—as it is not in America, and there for obvious reasons—that there should be a single house upon the route, or even at the terminus to which you push forth the line, provided only, that in site and other circumstances it is well chosen. Open the line, and we are told it will stand much in the position of the primal highway for travellers—a long river. Inhabitants will flock to its banks, and communications will be made with it from all sides; houses will, as if by magic, spring up in the wilderness, and swell into villages; while at the remote terminus, an important, rich, and flourishing town, like Buffalo, will, in the course of some ten years, have burst and grown into a vigorous existence. And thus, in a short time, the direct line, in which there is no original error to correct, will pass through a large and rich population which it has itself attracted; will have feeders by branches to all those towns that stood out of its route when projected; and there will be no more notion of a competing line to it, than there would have been in former days to the Appian Way. Such is the view of some as to the principle on which a decision should be made of the route of the line. Though we believe that it is in some respects deserving of attention, yet such has not been the method usually adopted, nor would it be commonly successful.

With the Ordnance map in his hand, and the mountain barometer in his pocket, with which to take "flying levels," the engineer visits the districts through which the line may pass, and perhaps makes a selection from three or four eligible routes, each of which may be liable to a variety of modifications, as his discretion may dictate; while the magnitude of the question at stake gives an importance to his decisions, which few can appreciate if they have not felt the weight of similar responsibility. The acquaintance with the features of the country which is requisite may be illustrated by the fact, that when Mr. R. Stephenson was determining the route of the London and Birmingham Railway, he walked over the intervening districts no fewer than twenty times. Meanwhile, trial-shafts and borings are made by the assistants of the engineer, which reveal the geological formation of the various strata, and present important considerations which will have to be regarded in making his selection.

The difficulties which arise in planning the course of a railway are

sometimes very great. A few years ago an engineer of eminence was sent by the Grand Junction Railway Company to ascertain the best route for a line among the hills of Cumberland into Scotland. On returning, he declared that, though he had been able to see his way as far as a certain place in Westmoreland, yet that no man living could construct a railway further in that direction, and that the project must be abandoned. Science, however, was not thus to be outdone; and in less than two years from the delivery of that unreserved opinion, a country surveyor produced plans of a line which, without a tunnel, or any other work of special difficulty, now runs to Scotland by the western side of the island.

Having completed his observations, and collected the information of his assistants, the engineer now "sums up the evidence," and marks out the route which the line shall take; while such is the ability of the men on whom these duties have devolved, that few are the instances in which their verdicts have been open to subsequent impeachment. In the course thus selected, rivers and streams are crossed as near their sources as possible; hills, valleys, and undulating grounds are passed or only touched; towns and places where land is expensive are approached with caution; pleasure grounds and gentlemen's seats are avoided; and a general estimate is made for setting off the amount of cuttings or embankments as nearly as possible against one another.

A LEVELLING PARTY.

The route of the line must now be surveyed and levelled with the utmost precision. Surveying may be described as the art of determining the form and dimensions of tracts of ground, with any objects

which may exist thereupon. A survey is accompanied by a representation on paper of all these objects, and frequently by a delineation of the slopes of the hills, as the whole would appear if projected on a horizontal plane. When railways or canals are to be executed, a survey of the ground is combined with the operation of levelling, by which a line or surface exactly level is found, and by which it is also ascertained how much higher or lower any given point on the surface of the earth is from any other. The practice of levelling, therefore, consists in finding or making two or more points that shall be on a level, and in comparing the points thus found with others, to ascertain the difference in their elevation. By the aid of this information, the engineer is enabled to adopt appropriate measures for reducing the whole of the new line to a level, or to such gradients as it may be deemed most expedient to adopt.

The work of surveying and levelling for railways has often been attended with no small difficulty, apart from the natural obstacles to be encountered. The annoyance felt by the owners of pleasure grounds at the invasion, or even the immediate proximity, of railways, has occasioned many serious quarrels between the surveyors and the agents of the proprietors. The opposition thus raised, however, seldom caused any ultimate inconvenience to the projectors, who contrived, by fair means or foul, to accomplish their design.

This hostility was evinced from the very commencement of railway enterprise, as the following interesting dialogue, which took place in the Committee of the House of Commons, on the 27th April, 1825, will show. The questioner is Mr. Serjeant Spankie, and the respondent George Stephenson, Esq.:—

"*Q*. You were asked about the quality of the soil through which you were to bore in order to ascertain the strata, and you were rather taunted because you had not ascertained the precise strata; had you any opportunity of boring?

"*A*. I had none; I was threatened to be driven off the ground, and severely used if I were found upon the ground.

"*Q*. You were quite right, then, not to attempt to bore?

"*A*. Of course, I durst not attempt to bore after those threats.

"*Q*. Were you exposed to any inconvenience in taking your surveys in consequence of those interruptions?

"*A*. We were.

"*Q*. On whose property?

"*A*. On my Lord Sefton's, Lord Derby's, and particularly Mr. Bradshaw's part.

"*Q*. I believe you came near the coping of some of the canals?

"*A.* I believe I was threatened to be ducked in the pond if I proceeded; and, of course, we had a great deal of the survey to make by stealth, at the time when the persons were at dinner; we could not get it by night, for we were watched day and night, and guns were discharged over the grounds belonging to Captain Bradshaw, to prevent us; I can state further, I was twice turned off the ground myself (Mr. Bradshaw's) by his men; and they said, if I did not go instantly they would take me up, and carry me off to Worsley.

"COMMITTEE. *Q.* Had you ever asked leave?

"*A.* I did, of all the gentlemen to whom I have alluded; at least, if I did not ask leave of all myself, I did of my Lord Derby, but I did not of Lord Sefton, but the Committee had—at least I was so informed; and I last year asked leave of Mr. Bradshaw's tenants to pass there, and they denied me; they stated that damage had been done, and I said if they would tell what it was, I would pay them, and they said it was two pounds, and I paid it, though I do not believe it amounted to one shilling.

"*Q.* Do you suppose it a likely thing to obtain leave from any gentleman to survey his land, when he knew that your men had gone upon his land to take levels without his leave, and he himself found them going through the corn, and through the gardens of his tenants, and trampling down the strawberry beds, which they were cultivating for the Liverpool market?

"*A.* I have found it sometimes very difficult to get through places of that kind."

In some cases large bodies of navvies were collected for the defence of the surveyors; and being liberally provided with liquor, and paid well for the task, they intimidated the rightful owners, who were obliged to be satisfied with warrants of committal and charges of assault. The navvies were the more willing to engage in such undertakings, because the project, if carried out, afforded them the prospect of increased labour. Great difficulties were thus encountered in making the surveys for the London and Birmingham Railway; and though it is certain that in every case as little injury as possible was done, because it was the interest of those concerned to conciliate the landed proprietors, yet in several instances the opposition was very decided, and even violent. In one case no skill nor ingenuity could, for a considerable time, evade the watchfulness and resolution of the lords of the soil, and the survey was only accomplished at night, by the aid of dark lanterns. On another occasion, when Mr. Gooch was taking levels through some of the large tracts of grazing land a few miles from London, two brothers, by whom the land was

occupied, came to him in great anger, and insisted on his immediately leaving the property. He contrived to learn from them that the adjoining field was not theirs, and he therefore remonstrated but briefly with them, and then walked quietly through a gap in the hedge into the next field, and planted his level on the highest ground he could find—his assistant remaining at the last level station, which was about one hundred and sixty yards distant, apparently quite unconscious of what was taking place, although one of the brothers was moving very quickly towards him, for the purpose of sending him away. Now, had the assistant moved his staff before Mr. Gooch had taken the sight at it through the telescope of his level, all his previous work would have been lost, and the survey would have had to be completed by some other means, or not at all. The moment Mr. Gooch commenced looking through the telescope at the staff held by his assistant, the grazier nearest him, spreading out the skirts of his coat, tried to place himself between the staff and the telescope, in order to intercept the view, and at the same time shouted violently to his comrade, desiring him to make haste and knock down the staff. But before this could be done, the observation was completed, and the work was accomplished.

In another instance a clergyman offered such decided opposition to the intruders, that the expedient was resorted to of surveying his property during the time he was engaged in his public duties on the Sabbath. This was accordingly done by a strong force of surveyors being in readiness to commence their operations by entering the grounds on one side, at the time that they saw him fairly off them on the other; and, by an organised and systematic arrangement, each man came to the conclusion of his allotted task just as the reverend gentleman came to the conclusion of his sermon; and before he had reached home, the deed was done.

In the surveying of the land for a railway at Glenfallach, a serious affray took place between the Breadalbane people and the agents of the projectors. The first survey of the line had been completed, but it was found necessary that an engineer should be sent to re-examine a small portion near Crainlarich. Some days having elapsed since the original parties had retired, and the new comer having only one attendant with him, he at first attracted little attention. But the hated theodolite was at length recognised, and the miners of Clifton were summoned to the defence of the land from the assaults of the railway officials. It was reported that the surveyor drew a sheath knife, but whether in his own defence, or for the purpose of removing the screen of plaids which was interposed between him and the measuring-rod,

did not appear; but by this time the survey being almost completed, the struggle was terminated.

Another disturbance took place near the village of Appleton, about eight miles from York, between some "watchers" and a railway surveyor and his assistant, who had been employed by the Cambridge and Lincoln Company. It appears that the party attempted to enter a field of Sir W. Milner, Bart., but their progress was opposed, and a very serious conflict ensued, the surveyors making a determined attack on the men who obstructed them. The servants of the Baronet, however, obtained a reinforcement, and the aggressors were taken in custody to York. On the following day the defendants appeared at the Castle, under the charge of having committed assaults, one man being dangerously wounded in the head, and two others being severely injured. After much mutual recrimination, the magistrates bound the surveyor and his assistants to keep the peace for six months; and as their commission was nearly executed, they had little difficulty in complying with the requirement.

One of the most determined struggles of this kind took place on the estate of Lord Harborough. That nobleman gave notice to the friends of the Peterborough and Nottingham Junction Railway, that he should not permit their surveyors to enter his land. In the maintenance of this resolution a struggle ensued at Saxby, near Stapleford Park. The contest begun by one of his Lordship's men standing before the surveyor, and preventing his carrying the chain forwards, on which the latter drew a pistol, and threatened to shoot him. Undaunted by the danger, the keeper replied, "Shoot away!" and a slight scuffle ensued, in which the pistol was, fortunately, not discharged. An effort, too, having been made to survey the park from the towing-path of the Oakham Canal, which was considered to be a public road, a number of Lord Harborough's people obstructed the surveyors, seized their instruments, and put the parties themselves in a cart, to take them before a magistrate. His worship, however, being from home, it is said that his Lordship's steward ordered them to be turned out of the cart, and this was accordingly done, and some of the surveying instruments broken. The solicitor of the Company subsequently saw the steward, and declared his proceedings to have been altogether unjustifiable, but intimated that, if no further obstruction were offered, legal measures would not be resorted to in the matter.

The surveys for the projected railway being at length completed, it is required that copies of the document should be deposited with the clerks of the peace of the counties through which the line is intended to pass, and also with various other parties. The parochial

authorities must also be duly informed of the proposal, and must have their proportion of the copies of surveys; while every landholder will receive a section showing the depth of cutting or embankment across his estate.

These arrangements being at length completed, the subscriptions for undertaking the work in legal form being obtained, and other preliminaries settled, the duty of "fighting for the Act," as it is termed, commences. If this is obtained, the petition is transmuted into an Act of Parliament, and by it the subscribers are authorized to incorporate a Company for executing the proposed design, and are provided with the powers requisite for the purpose.

The extent to which legislative interference ought to go in reference to railways is a matter which has caused much discussion, and brief reference must be made to it. Some have argued very strenuously that the efficiency and independence of public efforts is the best safeguard of the public weal, and that whatever the Government has touched in the way of interfering with private undertakings, it has only marred. On the other hand, Englishmen rightly cherish a deep hatred of monopolies, and railways are essentially of this nature. Of all tyrannical powers in the country, a railway Company is the most formidable. It applies to Parliament to be endowed with powers which the common law denies to the Sovereign herself; it seeks for authority by which, without leave, and in defiance of it, it may invade property, having purchased it at a price which, from local associations or circumstances, may be far below its value to the possessor; it levels grounds and houses without remorse, be they grange or cottage; or, what is worse, it cuts close by and utterly mars the estate without actually touching it; and fells down, without mercy, the oaks which ancestors may have planted, and destroys for ever that which may be most dear to its proprietor. And all this must be submitted to, because the public weal is paramount to private considerations.

If, then, railway Companies have received such extraordinary powers from the Legislature to create a property for their private and indefeasible profit, and if individual interest has been sacrificed in order to confer these advantages, the public is sufficiently involved in the matter to warrant the exercise of public control. Hence, if a monopoly is granted, the power must not be irresponsible. The Company has incurred great risk and cost—let it derive the advantage of any success which may reward its efforts; but at the same time, as great interests have been sacrificed in granting the required power to the Company, and as these are permanently and deeply involved in the matter, it is right that there should be a certain legislative control.

It has been maintained by many, and is still argued by some, that the State ought to possess itself of the railway property of the country by compromise and compensation; and it is hinted that if this had been done at first, the economy of its construction, and the efficiency and success of its working, would have made an important item in the national revenue, and have materially tended to reduce that never-ending source of annoyance—the national debt. This step, it is affirmed, ought to have been taken when the success of the Liverpool and Manchester Railway had established the practicability of the new motive agency. Year after year, it is said, far-seeing men pointed out to the governments of the day the advantages of such a measure, but divided cabinets, and parties struggling for power, refused to entertain the proposal. Even after speculation had evidently run wild, and the walls of Parliament were ringing with the cries of infuriated gamblers struggling for legislative authority to compass each other's ruin, the cabinet looked on with sullen indifference, remained deaf to the calls of practical wisdom, and blind to the true interests of the country.

Others have expressed the decided conviction, that the trunk railways ought to have been constructed by the Government, as in France, leasing them to Companies who would undertake the completion and management of them for a certain term of years, at the expiration of which the works themselves would become the property of the nation. Nor was such an undertaking without precedent; though it must be admitted that such attempts have been far from profitable. Thus the Caledonian Canal cost upwards of a million of money, and the revenue drawn from it does not defray its own expenses, to say nothing of the return of interest on the capital expended. Be this, however, as it may, the history of the establishment of railways certainly presented a golden opportunity, which required only men of capacity and energy to have turned to great and permanent advantage.

There are some who have gone so far as to say, that the State has systematically practised oppressive taxation and unjust interference with the management of railways, in order to paralyse their energies, and to reduce their dividends, that they may thus be enabled to buy up the deteriorated property of shareholders; while others have denied this accusation, on the ground that it presupposed a degree of sagacity which the Government has never yet evinced, combined with a degree of injustice of which it is incapable. A full discussion of this subject would involve a transgression of the limits assigned to us; and we shall be content to remark, that where scarcity of capital and want of com-

mercial enterprise are discovered among a people, governments have advantageously lent a fostering care in the construction of public works, and this course has been successfully adopted in France, Germany, and Belgium; but in England, the scientific eminence of the people, and the vast resources of the moneyed classes, have placed individuals in advance of the Legislature; and it has been in general considered necessary only to protect the interests thus created, and to maintain a judicious regard for those which have a prior claim.

In the early history of railway legislation, a Bill was allowed to pass if no opposition were made by those whose ground was to be traversed, and if there were no competing line. The growing importance and complexity of such affairs, however, introduced an important change. The Legislature investigated the conflicting interests which were involved in new lines. It was considered that the public required protection as well as the railways, and various questions of fares and charges came under their cognizance. Detailed reports were required of the committees, in 1836, to whom railway Bills were referred; and three years afterwards the constitution of the committee was improved by the admixture of "selected members," who were not locally interested; while, since the year 1844, those who are in any way connected with the particular line have been excluded. Committees are now usually composed of eight or ten members, who hear the arguments of counsel, and the evidence for and against the particular Bill; and are thus prepared to decide on the practicability and usefulness of the measure.

During the great railway campaign the immensity of business to be completed involved no small labour; and, despite the number of committees sitting at the same time on various Bills, great energy was required to support the honourable members through their undertaking. On one of them sat Daniel O'Connell, who presided as chairman in Group 14; for though excused from service as an aged member, he declined to avail himself of the exemption. Here, with sedate countenance, and deliberate action and words, he performed his onerous duties; and on St. Patrick's-day he appeared with an immense bunch of shamrock in his hat, resembling a good-sized cabbage, to the amusement of all.

The excitement during the "Railway Session" was altogether unexampled. Cabs rushed in and out of Palace-yard in fearful haste; clerks and witnesses tumbled over one another in their hurry; while the yard was thronged with anxious groups of engineers, surveyors, and shareholders, waiting for the meeting of the committees. Lobbies and ante-rooms were besieged by crowds of railway projectors,

parliamentary agents, and others connected with the great subject of the day; and the approaches to the committee-rooms were every now and then blocked up by sturdy porters and messengers, struggling under the weight of ponderous maps, plans, and sections. The old cloisters of the Westminster Palace rung with cabalistic sounds of "datum level," "gradient," "goods traffic," loop-line," and other foreign technicalities.

Counsel learned in the law hurried from their chambers to the committee-room, in obedience to the golden voice that invited them; and those who divided the spoil of the railway Companies had good reason to remember that "minting age." The desire of the promoters of railways to retain particular counsel in their several cases was—in accordance with the spirit of the times—a mania; and though, doubtless, the gentlemen so courted had created the demand for their services by the ability they had previously displayed in that particular line of practice, and the handsome fees with which their labours were rewarded, would, under ordinary circumstances, have gained their best efforts on behalf of the undertaking; yet, as they had not the power of ubiquity, their exertions were necessarily limited. Often had they to rush from one committee-room to another before they had said half they wished in advocacy of the views of their clients, because their presence was demanded elsewhere; and thus they spent the hours from eleven to four almost in a state of bewilderment—the only idea that presented itself clearly before them being that, for all this bustle and work, they were perhaps receiving fees to the amount of £200 or £300 a-day. It is affirmed that practice before Committees of the House of Commons has, in many cases, produced three times larger incomes than ever have been acquired in the regular pursuit of the profession. Among others, Mr. Cockburn has here been very successful; and in 1844, 1845, and 1846, Mr. Charles Austin is said, on good authority, to have made, on an average, £40,000 a-year. The Hon. John Talbot is known to have received more than £12,000 a-year; and juniors, who never obtained £200 a-year at Westminster Hall, made £3000 or £4000 per annum during those three years before committees. Many heavy items of the receipts of principals were enjoyed as retainers, merely to prevent their appearing on the other side.

While counsel thus performed such valuable services in the cause of railways, there was another class scarcely less important; we refer to the witnesses. Hundreds and thousands of these were in request. There were plenty of people to be had, who, having nothing else in the world to do, for an adequate consideration could express a

very decided, and of course competent, opinion in reference to a new line, the resources of a town in their neighbourhood, or the evils of a particular gradient or curve. Many there were, doubtless, who were honest and sincere enough; but numbers did the whole thing as a matter of business. And what could be easier than to give an opinion on such questions, and to make up for want of knowledge on the subject by the use of dogmatism in the statement?

The most amusing displays of the forensic genius of the counsel, and also of the engineers, who were pitted against each other, were made on these occasions. The engineer who appears on behalf of the line extols its virtues to the skies; while at the same time he declares that in an engineering point of view he cannot conceive that any difficulty can possibly arise in its execution. If a mountain, or a range of mountains stands in the way, he penetrates its depths with the utmost facility; and gives so eloquent and poetical a description of the interests, the delight, and the ease with which the work can be accomplished, that the Committee almost begin to think that tunnel-making is a pleasing and elegant recreation, or that it is as easy to hammer and blast a route through whinstone coeval with the creation, as to thrust a red-hot poker through a keg of Irish butter. If a broad river opposes the course of the new line, it can quickly be spanned by a bridge; if a valley intervenes, that may soon be crossed by a viaduct, which shall be as inexpensive as it is durable; if a series of gradients are indispensable, such as have never before been attempted, he has already provided against any evil arising therefrom, and has, indeed, rendered them a positive benefit; for they are so planned, that the impetus gained in the descent of the one incline shall be more than sufficient—whichever way the train may be going—to enable it to ascend the other. In short, there never was a line having a greater accumulation of positive advantages, and a greater absence of everything to discourage those connected with it.

The opposing engineer then rises. He gracefully expresses his utmost confidence in the general ability of his scientific friend, but he has on this occasion the misfortune to differ from him in opinion. He has surveyed with the greatest care the entire district to be traversed; and while he must say, the route which his friend has selected is, on the whole, the most judicious that could have been chosen, this only shows how manifestly wrong is the formation of a line at all, since the best is, in short, impossible. The engineering difficulties are extreme; and though the scientific abilities and perseverance of his friend are eminently distinguished, yet the cost

which would be inevitably incurred would be absolutely ruinous to the shareholders, and the works, if completed, most hazardous to the public. How is it possible, he asks with confidence, to tunnel through miles of quicksands and basaltic rock, which have been obviously arranged by Nature in such strata as to prevent any such undertaking? What engineering skill shall be competent to carry an embankment over marshes, in comparison with which

—"The great Serbonian bog,
'Twixt Damiata and Mount Casius old,
Where armies whole have sunk,"

sinks into utter insignificance? How can the piers of a viaduct be properly supported on a quagmire, or a cutting be made through a mass of floating mud? And all this is proposed to be undertaken in order to unite two towns which have not two interests or commodities in common, except one everlasting feud, which may be traced from son to sire back to the time of the Wars of the Roses! On the whole, therefore, he has been driven to the deliberate and conscientious conviction,—though upon personal grounds he should have greatly preferred that it had been otherwise,—that a more dangerous, impracticable, and worthless line has never been submitted to the consideration of Parliament.

Now, on the evidence thus advanced, and by the aid of plenty of a similar kind, the five highly-respectable gentlemen of the Committee have to form their opinion. Cross-examination only makes the matter worse. Each witness adheres closely to his opinions and his facts, forcibly reminding us of the witness who stated that a horse belonging to one of the parties concerned was fourteen *feet* high, and afterwards having said he was fourteen hands, the counsel interfered: "You said fourteen feet just now," he exclaimed. "Did I?" was the cool reply; "then if I said so, I 'll stick to it; I won't run away from the truth,—he *was* fourteen feet!"

So in the case we are describing. An indignant, atrabilarious lawyer, whose keen eyes twinkle in their deep sockets as he thinks he has found a point which will be fatal to his opponent, endeavours, "with the voice of an exasperated cockatoo," to make the engineer contradict himself; but that gentleman is not to be confused. He is the hero of a hundred committees; and he replies with an amiable tranquillity not surpassed by that which characterized the illustrious Sam Weller, and he sometimes returns his answers with equally damaging effect. If, perchance, he should be close-pressed by a wary counsel, he knows that he has one safe retreat, and immediately

escapes into a thicket of algebra, from which he vomits forth a furious and overwhelming volley of arguments, and terms about the reduction of the horizon, the curvature of the surface of the triangle in relation to the ellipticity of the earth; azimuths and longitudes, sines and cosines, logarithms and chord angles, optical squares, box-sextants, zenith distances, equatorial axes, and terrestrial arcs, into which neither counsel nor members dare to follow him; and thus fortified in the mysteries of his vocation, he can defend or defy the universe.

Many an odd scene occurred within the walls of select committee-rooms. The scrip of a particular Company is running up or down, according to the eloquence of the learned counsel or the want of it on either side. Business is proceeding listlessly in the room; one or two members are possibly asleep; others are chatting or comparing the horticultural specimens in their respective button-holes, while a junior counsel is examining some witness who demonstrates that the line may cross a particular turnpike without disturbing the equanimity of mind of one thistle-browsing donkey, or one nervous gosling. Immediately on his conclusion, a "leader" on the other side has elbowed his way through the crowd, and, to the horror of the junior, starts up, and formally announces that he has a proposition to make which must settle the whole question, and which is at the same time so advantageous to all parties, that no objection can possibly be urged by the other side. The Committee discards the flowers and other minor considerations, and listens with attention to the proposal; and before it is concluded, the affrighted junior has despatched half-a-dozen attorney's clerks for his leader; and, in reply to the query of the chairman as to what he is prepared to say in answer to the unanswerable suggestion, he begs permission to wait a few moments.

One of the messengers has at length found the principal in the middle of a speech in reference to another line, the merits of which he is advocating. He has, perhaps, just stated, that he shall now proceed to demonstrate the necessity of the line in favour of which he is engaged, when a mysterious whisper reaches his ear, and, without the alteration of a muscle of his countenance, he adds, "But the case is so clear, that it would be altogether a work of supererogation to proceed with it; and I shall therefore leave the witnesses in the hands of my learned friend, Serjeant So-and-so, and beg permission of the Committee to withdraw for a few minutes." Away he goes, and arrives just in time to save his junior from going off into a fit of apoplexy; and having received from him certain instructions, he

pours forth a torrent of declamation against the aforesaid unanswerable proposition, till his presence is required elsewhere.

Or perhaps some junior, who is "rising," and wishes to come off in a style that shall attract the attention and approval of solicitors, has been intrusted with the case, and delivers himself of a speech which he has been elaborately preparing during the preceding month, and, dressed in wig and gown, has recited, on three several occasions, to his admiring sisters, to say nothing of private rehearsals which he has had for his own peculiar advantage. Of this class of speeches, a description, not excessively over-coloured, was given by a writer in *Blackwood's Magazine*, in 1845:—"I swear to you, Bogle," he says, "that no later than a week ago, I listened to such a picture of Glasgow and the Clyde, from the lips of a gentleman eminent alike in law and letters, as would have thrown a diorama of Damascus into the shade. He had it all, sir,—from the orchards of Clydesdale to the banks of Bothwell; the pastoral slopes of Ruglen, and the emerald solitudes of the Green. The river flowed down towards the sea in translucent waves of crystal. From the parapets of the bridge you watched the salmon cleaving their way upwards in vivid lines of light. Never did Phœbus beam upon a lovelier object than the fair suburb of the Gorbals, as seen from the Broomielaw, reposing upon its shadow in perfect stillness. Then came the forest of masts, the activity of the dockyards, and

> 'The impress of shipwrights, whose hard toil
> Doth scarce divide the Sunday from the week.'

Further down, the villas of the merchant-princes burst upon your view, each of them a perfect Sirmio; then Port Glasgow, half spanned by the arch of a dissolving rainbow; Dumbarton, grand and solemn, as became the death-place of the Bruce; Ben Lomond, with its hoary head swathed in impenetrable clouds; and lo! the ocean and the isles. Not a Glasgow man in the committee-room but yearned with love and admiration towards the gifted speaker, who certainly did make out a case for the Queen of the West, such as no matter-of-fact person could possibly have believed. And all this was done by merely substituting a Claude Lorraine glass for our ordinary dingy atmosphere. The outline was most correct and graphic; but the secret lay in the handling and distribution of the colours. I shall not wonder if the whole Committee, clerk included, come down this autumn to catch a glimpse of that terrestrial paradise."

While the arguments and evidence have thus been advanced within the committee-rooms, great efforts have been made "out of doors" by the friends of the Bill. Witnesses have been collected wherever they could be useful, and without regard to expense. If possible, the landowners whose estates the line will traverse have been induced to concur in the scheme, and to signify their assent and consent thereto before the honourable and select Committee. Merchants, manufacturers, and tradesmen have been brought from the towns through which it is intended that the line should pass, to express their opinion in its favour. Objectors to the railroad are conciliated, to effect which all practicable means are rendered available, if they are men of note or influence. The system of "buying off" opposition has, indeed, been carried on to a prodigious extent. When landowners have been asked by the Company whether they approved or not the general design of the proposed railway, they have frequently answered in the negative, although they have openly avowed their anxiety that the railway should be formed, as it would not only be a matter of great personal convenience to them, but that they hoped to gain a "good picking" from it; and they have admitted, that their sole object in thus opposing the line was to obtain from the Company a larger sum of money for their land. Of the style in which opposition was carried on in the committee-rooms, some illustrations may be given:—

Often a proprietor, who owned perhaps half an acre, was brought forward by those who were interested in opposing the measure, and counsel, agents, and witnesses were supplied him, without regard to expense, till every means had been exhausted of thus producing, through him, an adverse feeling in regard to the project. Some one else was then advanced for the same purpose; and though it was known to every one in the committee-room that these were only the agents of a rival line or interest, yet on the same day the same questions were raised, the same arguments enforced, the same sort of evidence given, to show that all railways were injurious, in perhaps twenty different rooms.

One noble lord had an estate near a proposed line of railway, and on this estate was a beautiful mansion. Naturally averse to the desecration of his home and its neighbourhood, he gave his most uncompromising opposition to the Bill, and found, in the Committees of both Houses, sympathizing listeners. Little did it aid the projectors that they urged that the line did not pass within six miles of that princely domain; that the high road was much closer to his dwelling; and that, as the spot nearest the house would be passed

by means of a tunnel, no unsightliness would arise. But no; no worldly consideration affected the decision of the proprietor; and, arguments failing, it was found that an appeal must be made to other means. His opposition was ultimately bought off for twenty-eight thousand pounds, to be paid when the railway reached his neighbourhood. Time wore on, funds became scarce, and the Company found that it would be best to stop short at a particular portion of their line, long before they reached the estate of the noble lord who had so violently opposed their Bill, and whose aid they felt themselves sure of obtaining for their second Bill, by which they sought to be released from the obligation of constructing the line which had been so obnoxious to him. What was their surprise at finding this very man their chief opponent, and then fresh means had to be adopted of silencing his objections!

Other instances may be given. A line had to be brought near to the property of a certain member of Parliament. It threatened no injury to the estate, either by affecting its appearance or its intrinsic worth; and, on the other hand, it afforded him a cheap, convenient, and expeditious means of communication with the metropolis. But the proprietor, being a legislator, had power at head-quarters, and by his influence he nearly turned the line of railway aside; and this deviation would have cost the projectors the sum of *sixty thousand pounds*. Now it so happened that the house of this honourable member, who had thus insisted on such costly deference to his peculiar feelings respecting his property, was afflicted with the dry rot, and threatened every hour to fall upon the head of its owner. To pull down and rebuild it, would require the sum of *thirty thousand pounds*. The idea of a compromise, beneficial to both parties, suggested itself. If the Railway Company rebuilt the house, or paid £30,000 to the owner of the estate, and were allowed to pursue their original line, it was clear that they would be £30,000 the richer, as the enforced deviation would cost £60,000; and, on the other hand, the owner of the estate would obtain a secure house, or receive £30,000 in money. The proposed bargain was struck, and £30,000 was paid by the Company. "How can you live in that house," said some friend to him afterwards, "with the railroad coming so near?" "Had it not done so," was the reply, "I could not have lived in it at all."*

One rather original character sold some land to the London and Birmingham Company, and was loud and long in his outcries for compensation, expatiating on the damages which the formation of

* Fraser's Magazine.

the line would inevitably bring to his property. His complaints were only stopped by the payment of his demands. A few months afterwards, a little additional land was required from the same individual, when he actually demanded a much larger price for the new land than was given him before; and, on surprise being expressed at the charge for that which he had declared would inevitably be greatly deteriorated in value from the proximity of the railway, he coolly replied: "Oh, I made a mistake *then*, in thinking the railway would injure my property; it has increased its value, and of course you must pay me an increased price for it." Thus it is that in dealing with individuals, men have distinct ideas of justice; while in dealing with the abstraction called a railway proprietary, many seem to think themselves entitled to overreach and to cheat without either restraint or dishonesty.

On one occasion, a trial occurred in which an eminent land-valuer was put into the witness-box to swell the amount of damages, and he proceeded to expatiate on the injury committed by railroads in general, and especially by the one in question, in *cutting up* the properties they invaded. When he had finished the delivery of this weighty piece of evidence, the counsel for the Company put a newspaper into his hand, and asked him whether he had not inserted a certain advertisement therein. The fact was undeniable, and on being read aloud, it proved to be a declaration by the land-valuer himself, that the approach of the railway which he had come there to oppose, would prove exceedingly beneficial to some property in its immediate vicinity, then on sale.

An illustration of the difference between the exorbitant demands made by parties for compensation, and the real value of the property, may be mentioned. The first claim made by the Directors of the Glasgow Lunatic Asylum on the Edinburgh and Glasgow railway is stated to have been no less than £44,000. Before the trial came on, this sum was reduced to £10,000; the amount awarded by the jury was £873.

The opposition thus made, whether feigned or real, it was always advisable to remove; and the money paid for this purpose, though ostensibly in the purchase of the ground, has been on many occasions immense. Sums of £35,000, £40,000, £50,000, £100,000, and £120,000, have thus been paid; while various ingenious plans have been adopted of removing the opposition of influential men. An honourable member is said to have received £30,000 to withdraw his opposition to a Bill before the House; and "not far off the celebrated year 1845, a lady of title, so gossips talk, asked a certain nobleman to support a certain

Bill, stating that, if he did, she had the authority of the secretary of a great Company to inform him that fifty shares in a certain railway, then at a considerable premium, would be at his disposal. This, of course, is no bribery; but we wonder whether it explains the reason of some people having so many friends in parliament."* Exceptions there have been—we hope there have been many—to this spirit of self-aggrandizement. It was of such that Sir Robert Peel spoke, when, on turning the first sod of the Trent Valley line, he said to its Directors:—"I assure them that there are many persons in this neighbourhood who have not scrupled to sacrifice private feeling and comfort, by consenting to their land being appropriated to the Trent Valley Railway. They have given that consent from a conviction that this undertaking was one conducive to the public benefit, and that considerations of private interest should not obstruct the great one of the public good. But they have given their consent also in the confidence that this is not one of the ephemeral schemes proposed for mere gambling speculations, or from mere cupidity of gain. They have given their consent in the confidence and belief that the Directors of this railroad are men influenced by the honourable ambition of conferring a public benefit on the district with which they are immediately connected, and that they look for reward, not so much to immediate pecuniary gain, as to the grateful acknowledgments of their fellow-citizens for a service rendered to them. On these grounds there has been accorded a willing assent to the passage of the railway through this locality."

One pleasing circumstance, however, highly honourable to the gentleman concerned, must not be omitted. The late Mr. Labouchere had made an agreement with the Eastern Counties Company for a passage through his estate, near Chelmsford, for the price of £35,000: his son and successor, the Right Honourable Henry Labouchere, finding that the property was not deteriorated to the anticipated extent, voluntarily returned £15,000.

The cost of purchasing land, and for compensation, has been stated by Mr. Laing, in a paper appended to the evidence given by him before a Select Parliamentary Committee on Railways, as follows:—

Newcastle and Carlisle Railway................	£2,200	per mile.
Grand Junction................................	3000	"
South Western.................................	4000	"
Manchester and Leeds..........................	6150	"
London and Birmingham, and Great Western	6300	"

while, on three other lines, the expenditure has averaged £14,000 per

* Herapath's Journal.

mile! Mr. Laing estimated that the positive *waste* of capital which had been incurred in this country, under the head of land and compensation, amounted to more than two millions and a half sterling,—a sum which has been immensely augmented since that return was made.

The practice of buying off opposition has not been confined to the proprietors of land. We learn from one of the Parliamentary Reports, that in a certain district, a pen and ink warfare between two rival Companies ran so high, and was, at least on one side, rewarded with such success, that the friends of the older of the two projected lines thought it expedient to enter into treaty with their literary opponent, and its editor very soon retired on a fortune. It is also asserted, on good authority, that in a midland county, the facts and arguments of an editor were wielded with such vigour, that the opposing Company found it necessary to adopt extraordinary means on the occasion. Bribes were offered, but refused; an opposition paper was started, but its conductors quailed before the energy of their opponent, and it produced little effect; every scheme that ingenuity could devise, and money carry out, was attempted, but they successively and utterly failed. At length a Director hit on a truly Machiavelian plan—he was introduced to the proprietor of the journal, whom he cautiously informed that he wished to risk a few thousands in newspaper property, and actually induced his unconscious victim to sell the property, unknown to the editor. When the bargain was concluded, the plot was discovered; but it was then too late, and the wily Director took possession of the copyright of the paper, and the printing-office, on behalf of the Company. The services of the editor, however, were not to be bought, he refused to barter away his independence, and retired, taking with him the respect of both friends and enemies.

At length the arguments and witnesses before the Parliamentary Committees, in reference to our ideal line, are concluded on both sides; and, after due deliberation, a decision has to be made. It would be unreasonable to expect that this should always be in accordance with wisdom; it is indisputable that in some instances grievous and irreparable errors have been committed. In the case of the Brighton line, of the three brought before the Committee, we are assured that the most expensive, the worst, and the shortest only by a trifling distance, was selected. One route was proposed, which, passing through a natural gap in the hills, avoided the necessity of tunneling, and the enormous outlay and permanent inconvenience consequent thereon. This line was dis-

countenanced, and the present long-tunneled and costly one had the preference.*

Several weeks have perhaps been occupied in the production of the evidence; it is now printed, and stitched together in the form of a blue book, and is accompanied by the Report of the Committee, and by addenda, appendices, and other documents intended to throw light on the subject. During the session of 1844, between forty and fifty of these Committees sat, heard evidence, and issued five and forty blue books, with their equally blue satellites; while the number in later years has been greatly increased. The moderate estimate of twelve hundred and fifty pages each for those of 1844 will give no fewer than sixty thousand folio printed pages, as one of the results of a year of railway enterprise.

At length, the decision of the Committee on a particular Railway Bill has been made, and is about to be announced. On the doors of the room being opened, it is entered by a dusky avalanche of counsel, solicitors, shareholders, speculators, brokers, and idlers, who collect along and in front of the barrier, where the mass is condensed into a hot, anxious, and impatient conglomerate, the ingredients of which endure a sort of *felo de se in petto* for some two or three apparently never-ending hours: or perhaps, on the conclusion of the evidence and the speeches, they are made to wait in the lobby till the selected senators have made up their minds as to the propriety of passing or rejecting the Bill. Some are pale with anxiety and alarm, some are flushed with excitement, while the counsel look on with comparative indifference—for they have done their work and received their fees. Whispers begin to circulate that the Committee-men are two to two, and that the chairman, who has the casting vote, is unable to make up his mind. But at length the tinkling of a bell breaks in upon the buzz of conversation, a fresh thrill of anxiety rushes through the minds of the friends and foes of the new project, for now the fate of the line is to be determined: the Committee comes from its retirement by a side door into the waiting-room, and, headed by the chairman, communicates the decision of the learned members. Profound, intense silence reigns as he announces the verdict that he is instructed to state that "the Committee having heard evidence, are of opinion that the preamble of the Bill has, or has not, been proved, and they intend to report accordingly." A buzz, and a rush to the door follows, and perhaps a cheer arises from the victors. On the occasion of a favourable decision being given on the London and York line, which was fought inch by inch through the Committees of

* Herapath.

both Houses with special acrimony and perseverance, the moment that it was pronounced, stentorian lungs shouted, "Bravo! hurra!" which was accompanied by the stamping of feet and umbrellas, and was followed by a general fight for the door, at which a fearful struggle took place. The confusion was complete, and after repeated demands for "Order," which were utterly ineffectual, the chairman could only give expression to his indignation by declaring that the conduct of those present was "exceedingly indecent."

The announcement thus made has sometimes been rendered available by parties interested in the line. One darts away, perhaps by special means he has provided for the purpose, and succeeds in selling or buying on' Change a lot of shares, during the five minutes that intervene before the arrival of the intelligence; and is thus enabled, at the expense of others, to save himself from the loss he would otherwise have incurred, or to make a handsome profit on the strength of his early information.

Of the labour, intellectual and physical, to which honourable members were exposed in these interminable discussions, the reader will already have gained some idea. Flesh and blood might well revolt at the task. While the attention and strength of the members of the Legislature were thus absorbed, how would it be possible for them to enter with vigour on the great public questions of the day! It has been well remarked, that if after three days' patient hearing of the witnesses and lawyers on some of these conflicting interests, a Committee-man has one tangible idea floating in his head, he must be either an Alcibiades or a Bavius—a heaven-born genius, or the mere incarnation of a fool!

The authority of the Legislature thus obtained empowers the Company to take possession of a width of land of sixty-six feet, exclusive of that required for giving the necessary inclinations to the sides of cuttings or embankments. If a dispute arises between the Company and a landowner on the question of compensation, an arbitrator is appointed by each, to whose decision the case is referred, while sometimes the matter is brought before a jury. The sums claimed for land have been so exorbitant, that arbiters have often given less than a quarter of the amount demanded, and, in one case, only a fiftieth part was awarded. The cost of land can seldom be exactly estimated; and, in the construction of the London and Birmingham Railway, this item was more than double the anticipated amount.

The requirements of the Government on railways are enforced under the supervision of a department of the Board of Trade, consisting of an Inspector General, who has previously been an officer of

Her Majesty's corps of engineers, and two Civil Superintendents. No new lines can be opened without the previous examination, and certificate of approval, of the Inspector, who is responsible for the capability of the works to fulfil the duty to be required of them. All accidents must be reported to this department of the Board of Trade within forty-eight hours of their occurrence; and it has authority to sanction alterations for dangerous crossings,—for allowing the Company to appropriate land, in order to increase the safety of travelling by diminishing curves, or by other means,—for joining new lines to those already completed,—and to arbitrate on several matters which, under various enactments, are placed within their jurisdiction.

The dimensions to which Railway Acts sometimes extend, are enormous; they having, on many occasions, occupied from one to two hundred folio pages. It has been suggested that the cost incurred might be easily diminished by the enactment of a General Railway Bill, which would render unnecessary the repetition of items which have now to be specified in each separate Act.

The expenditure incurred in procuring legislative authority to construct railways has been, in many cases, scarcely credible. While the Parliamentary, surveying, and engineering costs of the Kendal and Windermere Company amounted to little more than two per cent. on the total outlay of the railway, we are assured that the Parliamentary costs of the—

Brighton Railway averaged	£4,806	per mile.
Manchester and Birmingham	5,190	"
Blackwall..........................	14,414	"

The Brighton line had to contend with three or four other Companies during two successive Sessions, and when the Bill was before the Committee, the expense of counsel and witnesses was stated at £1000 daily, extending over fifty days. The London and Birmingham line escaped much of this cost by coming earlier into the field; but the Parliamentary and surveyors' expenses even then amounted to £72,000, which must be regarded as a reproach on the system of legislation which thus permits impediments to be thrown in the way of works of great and acknowledged usefulness. It is also affirmed that "the solicitor's bill of South Eastern Railway contained ten thousand folios, occupied twelve months in taxation before the Master, and amounted to £240,000." One Company had to fight so hard for their Bill, that they found, when at length they reached the last stage—that of receiving the Royal assent—that their preliminary undertakings had cost nearly half a million of money,—a sum which

had been expended in merely acquiring the privilege of making a railway, and the interest of which has now to be paid by the passengers and goods that travel thereon. Without opposition, the same Bill would have been passed into an Act at a cost not worth mentioning, in comparison with the real expenditure.

The waste of capital, directly and indirectly, in the formation of railways, has been estimated at not less than £12,000,000, apart from the loss which has been incurred in the support of unsuccessful Bills and the maintenance of unsuccessful opposition. This sum would have been sufficient to construct a railway six hundred miles long, at the rate of £20,000 a mile; while the interest which has to be paid by the public in the increased cost of existing lines, amounts, at five per cent., to £600,000. Of the cost of projects which were ultimately unsuccessful, a single illustration may be given. In the celebrated battle of the Stone and Rugby Railway, the inquiry continued during sixty-six sitting-days, from February to August 1839, and, having been renewed in the following year, the Bill was finally defeated at an expense to its promoters of £146,000.

Much as it is to be regretted that costs so enormous have been incurred in the construction of railways, yet it must be admitted that, in many instances, the Companies are less to be blamed than to be pitied, as the victims of systematic and determined extortion. Some lines might be pointed out in which as much of economy has been observed as could be well anticipated, when the novelty and costliness of the enterprise are regarded. In favourable situations, English lines have been made at the rate of £10,000 per mile; and, in 1845, between one and two hundred miles of railway were constructed at not more than this expenditure. One of these, the Northampton and Peterborough Branch, of about forty-seven miles in length was constructed at a cost of £429,409; and the York and Scarborough, of forty-two miles, was made at an average of £6000 per mile. The Dundee and Arbroath cost £8,600 a mile, but, in unfavourable localities, railways have required more than £50,000; yet Mr. Lecount has computed that a line eighty miles in length, which would cost £960,000, or £12,000 a mile—which is far below the average—would require the following traffic *per day*, from each end, to pay the annexed dividends:—

Tons of Goods.		Passengers.	Dividend.
75	or	120	¼ per cent.
100	or	160	1 „
125	or	200	1¾ „
200	or	320	4½ „

2 The total expense per mile of some of the English railways was as follows:—

North Western	£41,612
South Eastern	44,412
Eastern Counties	46,355
Great Western	46,870
Manchester and Sheffield	56,316
Brighton	56,981
Manchester and Birmingham	61,624
Manchester and Leeds	64,588
Croydon	80,400
Dock and Birmingham Junction	100,000
Blackwall	266,000
Greenwich	270,000

Omitting the three lines last mentioned, which it would not be right to include in computing the average, the expense of the remainder is about £56,915 per mile.

If the reader now feels any lurking ambition to be concerned in the construction of a railway, he will be in some measure prepared for the emergencies of Parliamentary strife, and the demands that will be made at once on his patience and his purse, in the prosecution of his design!

RAILWAY BRIDGE AT MANCHESTER.

CHAPTER V.

Commencement of a Railway—Ceremony of turning the First Sod—The Ceremony—Commencement of the Bedford and Bletchley Line by the Duchess of Bedford—Difficulties in the Construction of Railways—Bungling of Directors—The Stepney No-Junction—Calculations of Engineers—Contracting—Gradients—Theoretical and Practical Considerations—Great Ascents attained by Means of Gradients—Illustrations—Undulating Railways—Concentration of Gradients—The Great Western Railway *versus* the South Western—Advantages of Undulating Railways—Inclines—A Chase—Curves—Objections to Curves—Effects of Curves—Laying of the Rails in Curves—Illustrations—Actual Commencement of the Works—Gullets—The Cutting—Tapping Springs—"Running"—Considerations to be regarded—Angle of Repose—Illustrations—Remarkable Cuttings—A Northern Cutting—The Haslingden Cutting—Blisworth Cutting—Tring Cutting—Bushey Cutting—Slips in Cuttings—New Cross Cutting—Slopes of Cuttings.

THE actual commencement of a great undertaking is always regarded with especial interest; nor is the feeling unnatural or unreasonable. There is an intangibility about the progress of a work, however important, that prevents our pointing to any particular portion as more worthy of note than another; and though its completion may excite feelings of gratulation, and the placing of the key-stone is viewed as "the consummation devoutly to be wished;" yet the beginning of an important work,—whether it be the founding of an alms-house, the inauguration of a Lord Mayor, or the turning of the first sod of a railway,—is usually and appropriately celebrated with public *éclat*. The custom, too, is time-honoured. The ancient kings of the East performed the ceremony of ploughing the first land or sowing the first corn in each year; and it was considered to be sound policy, as presenting a laudable example in the promotion of agricultural pursuits; and the Emperor of China still preserves this relic of patriarchal times. When the early Romans performed the ceremony of throwing a spear into the adjoining field of a neighbouring territory,—or, at a later period, into the *ager*

hostilis,—there could be no intrinsic merit in, or advantage from, the act; but it was regarded as not unworthy of their comparatively advanced age.

Thus is it, in our own time, with the railway. The noble and the peasant, the philosopher and the schoolboy, the poet and the ploughman, consider "the raising of the first sod" of a new line as an occasion of interest. And though some may have capacity or inclination to look only to the personal benefits which may, perhaps, accrue from the undertaking; others will ponder the great interests which are involved, and rejoice that they have lived to witness an era in which science and art have lent such aids to the prosperity and happiness of the family of man.

On the occasion of the commencement of a railway by these introductory ceremonies, there is usually an assemblage of the people of the neighbourhood, and of navvies "in their best," bearing gay banners and flags with appropriate inscriptions. A lively scene is commonly presented. A marquee, for the accommodation of the Directors and the visitors specially invited, occupies the ground in the immediate vicinity; and in due time appear the leading gentry of the county and neighbourhood, in their carriages, on horseback, or on foot. A procession is sometimes made, accompanied by a good band of music; and the company then form into a circle around the spot at which the first sod is to be raised. The chairman, of course, delivers an eloquent address, consisting of the popularized selections of the prospectus which had been issued some time before; in which he informs his enlightened auditory of the advantages that the line will produce in the neighbourhood, and perhaps intimate,—as did Mr. D. Salomons, at the commencement of the Reading, Guildford, and Reigate line,—that it may attract around it a population large enough to claim the privilege of representation in the Commons' House of Parliament.

The assistant-engineer then presents to the chairman a handsome spade of polished mahogany, with a silver blade, and a wheelbarrow, of similar materials and elegant design, is brought to the scene of operations. The spade is struck into the ground and the barrow filled, amidst the cheers of the assembly. The contents are trundled along a plank, and emptied at a little distance. Other influential gentlemen go through a similar process; and the company then proceeds to do honour to the occasion in the true John Bull style, of "having something to eat," and move off to the marquee erected on the grounds, where a *déjeûner* has been duly prepared. The navigators who are present, and who are to complete the work thus auspiciously

commenced, retire to a similar scene of operations, where a plentiful supply of roast beef and plum pudding is provided.

The commencement of the Bedford and Bletchley line was an exception to the ordinary proceedings on such occasions, the ceremony having been performed by Her Grace the Duchess of Bedford. The illustrious duke had engaged to preside, but was suddenly summoned to the metropolis on public business; and, to avoid delay in the proceedings, the duchess, assisted by Lord Alford, consented to officiate. Her grace was accompanied to the ground by a number of the Railway Directors, and other officials, and by many members of the principal families in the county. A salute of cannon and a band of music greeted her arrival; and the Chairman of the Company having made a few preliminary observations, handed her grace the spade, and requested her to do honour to the proceedings by commencing the works. Acknowledging the compliment, she pressed the spade into the earth; and Lord Alford, having addressed the company, threw off his great coat and hat and filled the barrow, amidst the cheers of the bystanders. The barrow was of beautifully-grained oak, from the Woburn estate, and was richly ornamented with silver. His lordship then wheeled the barrow along the platform, and led the way to the marquee which had been erected. After several toasts had been drunk, the duchess entered her carriage amid the cheers of the people and the report of cannon, taking with her, at the request of the contractors, the barrow and spade with which the work had been performed.

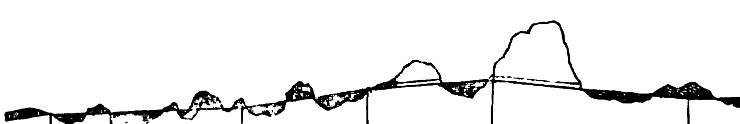
The railway Company which has been formed by the passing of the Act of Parliament has now to carry out the requirements of the statute. In attempting to do this, unforeseen difficulties have sometimes arisen, which have required considerable modifications of the original design, and have occasioned no small cost and delay. An illustration of this kind may be mentioned. In the "year of mania," the Blackwall Directors awoke from a long slumber, and determined, like the rest of the railway world, to be doing *something*. After duly considering the most advantageous spot to which they might make an extension, they appear to have calculated that the profits which would accrue from the conveyance of sausages and sausage-makers from Epping to London would furnish a return of at least ten per cent. The Eastern Counties authorities, however, at the same moment seem to have had similar designs on that interesting locality and its more interesting trading population; and these Companies determined to adopt the usual expedient of fighting for

possession. But another suggestion was offered. To stop short at Stratford was made the compromise of the new line, and the Act was obtained. But new difficulties now arose. The hard ground extended only as far as Bow; and the marshes where king Alfred turned the course of the Lea had to be traversed; and the apparition of innumerable bridges, culverts, and embankments, which would be required to surmount these difficulties, appalled the projectors. The thirty-five miles to Epping had already dwindled to three and a-half to Stratford. And then it was resolved to stop at Bow and a line was made from Stepney, on brick arches, with several costly bridges, at an expense of £250,000 for a distance of a mile and three quarters.

"But that was not all. When the 'line' was ready for opening, after a long incubation of engineers, surveyors, and solicitors, notice was given to the Eastern Counties to effect a junction with their rails. 'We do not need any junction,' said the wise men of the east. 'But you must, by Act of Parliament,' retorted the sages of Fenchurch-street. 'Cannot find it in the bond,' rejoined the eastern magi. 'To make a Railway from Stepney to Stratford,' says the deed; 'and, moreover, where are our trains to go to at Fenchurch-street, a *cul de sac*, where, if we once get in, there will be no emerging? Widen your line first!' And so the line remained—the Stepney No-Junction!"

So regardless were the projectors of railways during the far-famed mania, that a Bill was zealously promoted in Parliament, from Liverpool to Leeds, which would have required cuttings and tunnels for a very large proportion of the entire distance; and would, according to the estimate of a competent authority, have taken fifteen or twenty years to complete. At the head of this project was an engineer of eminence, who had made one of the longest railways in the country, and its Directors were men of high respectability. It narrowly escaped the sanction of the Legislature, and would probably have passed, had not a strong opposition to it been made by parties interested in a competing line.

It is now necessary for the engineer to prepare his various calculations for the intended railway with the greatest accuracy; and especially that the various gradients should be most judiciously arranged. The accompanying diagram represents a section of part



of a line which has to be reduced to something like a level. The gradients must accordingly be determined with reference to the amount of the earth-works; for, if the line were constructed at too low an average level, there would be an immense superabundance of material, from the cuttings being disproportionately deep and extensive; while, if it were estimated too high, a large amount of soil would have to be conveyed, at great cost, from various places off the line to construct the embankment. The chief object, therefore, is to have just enough earth-works to remove from the cuttings as will form the embankments; and just enough embankment to use up the material from the cuttings. The various positions, if any, in which it will be advisable to construct tunnels, have also to be decided, in connexion with the foregoing considerations; while innumerable minor problems have to be solved.

The line is now divided into lengths for construction; and it is announced, by advertisements or otherwise, that the Company is prepared to receive contracts for portions, varying from a few miles to several scores, according to their nature, the length of the line, and the resources of the contractors.

The execution of the works is seldom in the hands of the actual proprietors. Railway Directors are usually connected with "city" life, unacquainted with the details of the matters over which they have the supreme authority; and, though familiar with cash affairs, are really capable of managing only the general business of the Company. If, indeed, it were otherwise, they could not personally superintend the works under their charge; and hence it is found best to give the formation of the line to contractors who engage to complete the various parts at a specified cost. Contracting for railway-making has thus become a great business; and some experienced and wealthy men will now undertake the completion of the entire works of a long line. Meanwhile, the chief engineer has appointed his own staff of agents to superintend the work as performed by the contractors. Over each portion of from thirty to fifty miles an experienced engineer is generally appointed, having assistants, who superintend from ten to fifteen miles each. These are again aided by inspectors of the earth-works, masonry, mining, and of permanent way,—each with a special district under his observation. The chief contractors now, perhaps, sub-let the different works to sub-contractors, giving the earth-works to one, the masonry to another, and the ballasting to a third; and sometimes the sub-contractors again let out lesser portions to those who may be called sub sub-contractors. The last make their arrangements with various individuals for what are designated "little

jobs," in which are included the cartage of bricks, rails, or sleepers, for given distances; and even for the hire or feed of horses. The reader has, doubtless, been sometimes amused at the sight of a small country farmer trudging along by the side of what he was pleased to designate "a load of iron;" but which was, perhaps, nothing more than a few *chairs* laid at the bottom of his cart,—a burden amply sufficient for the powers of the aged or poverty-stricken horse between the shafts. The only duty thus left to devolve upon the Directors of the line, is to see that the contracts undertaken by the chiefs are duly and properly fulfilled within the stipulated period; to ensure which, security has been frequently required of ten per cent. on the amount of the contract. The navvies to whom the earth-works are let comprise three classes,—*excavators*, *runners*, and *trenchers*, each party having its own *ganger* to direct its labours.

It has been well exclaimed,—Happy is the nation whose annals are tiresome — the monotony of whose progress is unenlivened by conspiracies or intrigues, revolutions or battle-fields. The same remark applies to railways; and it may be truly said,—Happy are the shareholders who cannot boast of their engineering tact,—of overcoming great natural obstacles—of traversing deep valleys—of laying open the recesses of hills—or of burrowing the earth with tunnels. It is obviously of the first importance, in such undertakings, that the best discretion of engineers should be directed to the accomplishment of their work with the least demand for those monuments of their skill, which, though interesting in themselves, are frequently of so costly a nature as materially to interfere with the ultimate prosperity of the work.

A chief characteristic of a railway is the uniformity of surface which is attained by its construction. The increased efficiency of locomotives has, indeed, of late, permitted a much nearer approach to the natural form of the earth in the formation of lines than was before admissible; and vast cost has been thus avoided. Since the traction of the wheels on a railway is so much less than on common roads, it follows, that, when the force of gravity is brought into operation by an ascending plane, this opposing force, being proportioned to the load, is much greater than on a common highway. Thus, in the year 1833, experiments proved that, if a locomotive will draw, by the adhesion of four wheels, 67·25 tons on a level, it will only draw, by the same adhesion, 15·21 upon an incline of one in 100. At an inclination of one in fifty, an engine drew a load with difficulty; and at one in twelve it could not move at all,—the power being sufficient only to cause the wheels to revolve without advancing.

In looking to the estimates of heights to be attained, they may at first sight appear small and unimportant. An elevation of a foot in three or four hundred does not seem very difficult to be reached; but when the subject is examined somewhat more closely, it assumes a different phase. One in a hundred, for instance, does not only mean one inch in a hundred, but one mile in a hundred, a ratio which may be more clearly apprehended; that is to say, the traveller, in running a distance less than that between London and Birmingham, supposing the rise to be continuous, would reach a perpendicular elevation of a mile. In a country like this there would, of course, be no likelihood of any very long-continued and severe ascent, in whatever direction a line might be laid, unless we tried to reach Snowdon's summit by locomotive agency; but still such is the proportion of ascent made to the distance traversed on many parts of many lines.

The effect which the ascent of gradients has on the working of a line, involves many important considerations. It has been estimated that to mount a gradient of one in three hundred requires a tractive force nearly twice as great as is sufficient to move the same load at an equal speed along a level line; and it has been affirmed that to ascend an elevation of thirty feet demands as great a power as would suffice to propel an equal weight along a mile of level railway. These computations have, however, undergone important modification, from the great improvements which have been made in the power and adaptation of our locomotives; and engineers have been able to conduct lines through districts which a few years since were declared to be impassable. So important were these advances that, so early as 1845, the Report of the Board of Trade said, that "such gradients as were before thought objectionable are now adopted every day as a matter of course; and as the capabilities of the locomotive have been enlarged, gradients of a class which would have been, a few years ago, altogether impracticable, have come into general use."

The ascents made by means of a gradual inclination are sometimes very considerable, and when it is remembered that what is lost in the upward journey is, in a great measure, gained in the descent by trains coming from the opposite quarter, it must not be regarded as altogether a loss of power. Many of our readers, who have travelled from London on the Birmingham line, would be surprised to be informed, when they reached Tring, which is thirty-two miles from London, that they have ascended a perpendicular height of about three hundred and thirty feet since they left Euston-square, and that they are four hundred and twenty feet above the level of the sea. Many inclines too have been descended on the journey. This

estimate will serve as one out of very many which might be given of the method in which, by the aid of gradients, great elevations may be attained.

The gradients vary considerably, according to the nature of the line. Sometimes we may see on the finger-boards which are placed on the lines for the guidance of the engine-driver, that we are ascending at the rate of one in 2960, and then again we are descending at one in 100. Thus some parts of the inclined plane between Euston and Camden stations rise at the rates of one in sixty-six and one in seventy-five; that by which the Manchester and Leeds Railway is connected with the Victoria Station, at Manchester, descends at the ratio of one in fifty-nine for about 1000 yards, and one in forty-nine for 640 yards; and that by which the line from Edinburgh is conducted into Glasgow, has a slope of one in forty-two, for a distance of a mile and a quarter; yet, though, with heavy trains and "greasy* weather," an additional engine may be required, locomotives are exclusively employed. The Lickey incline, on the Birmingham and Gloucester line, furnishes conclusive evidence that a gradient of one in thirty-seven and a-half, for a length of more than two miles, may be worked by the aid of an engine constructed for the purpose, without serious inconvenience to an extensive traffic; and it also proves that such an incline may be descended without danger by the force of gravity, regulated by the action of the breaks.†

Two great principles have been recognized in the formation of the gradients of lines, in defence of each of which much has been urged; though the argument has lost not a little of its interest by the improvements in locomotives, which have enabled them to overcome greater diversities of gradients than were at first deemed practicable.

It was long contended that the only proper way to lay out railways was, by as near an aproximation as possible to a level surface; for though it involved a larger original outlay, it afforded the best means of satisfactorily working them when completed. On the other hand, it was maintained that lines formed on a series of undulations are equally advantageous with those that are perfectly level, because the impetus acquired in descending would be equivalent to that lost in mounting the inclines. The "undulating theory," as it may be styled, would, according to some, work well if applied in the form of a series of severe gradients, varying from thirty to forty feet a mile; and the North Union Railway, from Parkside to Preston, has been cited in illustration, five miles of which out of twenty-two have gradients of one in a hundred, while it is worked at less expense than some more uniform lines.

* For the rails. † Penny Cyclopædia.

The London and Birmingham Railway may be regarded as a model of the uniform system, having been constructed on the principle of obtaining the most perfect level for the purpose of economic working, making the amount of original outlay a secondary consideration. Hence the ordinary gradient on this line never exceeds one in 330, with the exception of the Euston and Camden incline, which was originally intended to be worked by stationary engines.

In some instances, when it is necessary to conduct a railway over a considerable elevation, discussion has arisen whether the rise and fall should be distributed as equally as possible over the line, or whether the gradients should be concentrated in a few steep planes. The latter course was adopted on the Liverpool and Manchester Railway. The main line has no slope exceeding one in 849, with the exception of two inclined planes each of about a mile and a half in length near Rainhill, where the ascent is one in eighty-nine and one in ninety-six, and where passing trains have the aid of an auxiliary engine. Similar means are adopted to overcome the Euston incline, on reaching the summit of which, at Camden, the pilot engine is detached and received into a siding without any stoppage of the train.

When the South Western Line was undertaken, this question had a thorough investigation. The project for this line was opposed in Parliament by the Great Western Railway Company, and one of the grounds of opposition turned on the question of gradients. The Great Western line was laid out so as to be almost a dead level over nearly one hundred and twenty miles, the only important inclination being arranged within a very short space, by means of two gradients, one of which amounts to a hundred and fifty-two feet a mile. The South Western, on the other hand, is characterized by long and steep gradients, and enormous earthworks, though it has none of the gigantic viaducts, bridges, or tunnels to be found on some lines. Lichfield is the summit level, being nearly four hundred feet above the termini at London and Southampton. One of the gradients extends from Lichfield tunnel, which is fifty-four miles from London, for a distance of seventeen miles, and is one in two hundred and fifty. It was indeed stated by the engineer who projected the line, in his Report to the Parliamentary Committee, that the aggregate of the earthworks would be sixteen million cubic yards—a mass of material sufficient to form a pyramid having a base of 150,000 square yards, and a thousand feet in height. The length and steepness of the gradient was principally occasioned by the extraordinary height of the ridge of the country which runs east and west through Hampshire near the middle of the line, and which it was necessary to traverse.

To overcome these variations in the surface, the line was laid out so as to undulate with a series of gradients, the prevailing acclivity of which was one in 250, or about twenty feet a mile. It was on the propriety of this arrangement that a great contest took place before a Committee of the House of Lords; and Dr. Lardner was employed by the London and South Western Company to investigate, by such means as theory and experiment could supply, the actual effects of such an undulating line upon the moving power.

It was argued by the partizans of the flat gradients of the Great Western, that the South Western line must be worked under disadvantages so enormous, owing to the resistance which would be produced by its gradients, that it would be expedient, if not indispensable, to avoid such gradients altogether, by taking a circuitous course, rendering the line longer, but thereby securing a nearly level line. In short, a portion of the Great Western itself was to form a part of such circuitous route; and thus the theory and the interests of the Company were made to coincide. Dr. Lardner, in reply, contended, that upon the undulating line there would be a compensating power in descending the acclivities, which would, to a great extent, balance the disadvantages in ascending them; that in a journey to and fro on such a line, the total expenditure of power would not be materially greater than upon a dead level; that the average speed would not be much less, although, in the course of the complete journey it would be much more variable; that on the ascending gradients the engine would have to overcome a greater resistance, to expend more power, and to move slower, but that this loss of power and time would be, to a great extent, made up in the descending gradients, where the resistance would be less considerable and the speed higher. This theory—for experience had not then established it—was fiercely attacked and ridiculed; but it prevailed with Parliament,—the Bill for the South Western Company was obtained, the line was finally constructed, and has been worked with great success.

The presence of inclines of importance on a railway always requires the adoption of special precautions on the part of the engine-men and guards of trains. In their descent, care must be constantly taken to have complete control over them by having the breaks well screwed up, so that, by a single turn of the handle they may be forcibly applied. The engine-man, however, must not place too much reliance on the assistance he may obtain from the breaks, but keep the train perfectly under his command by shutting off the steam at a sufficiently early period. It is recommended that engines or trains

should not descend steep inclines at a greater rate than about thirty miles an hour, except under special circumstances; and with heavy trains even this speed should not be attained. The usual pace down inclines of one in eighty to one in a hundred, was long stated at from twenty to thirty miles an hour, with a proportionate diminution of the speed according to the increased angle of the gradient; but the improvements in locomotion have modified this estimate. At the Euston incline the speed is usually not more than ten miles an hour, and at the Edgehill tunnel, Liverpool, it is less than half that amount.

In the ascent of steep inclines, it is sometimes necessary that a train should be divided into two parts; and special precautions have then to be adopted to prevent delay or accident. Great care must be exercised, that the last portion is not allowed to run down the incline after it is uncoupled from the remainder. On one occasion an accident of this kind occurred, which would have been attended with serious consequences, had not great activity and promptitude been displayed by the officers of the Company. Some wagons had been detached from a train, and were left standing on an incline without the breaks having been applied. The result was, that they set off by the force of their own gravity; and though they at first proceeded slowly, their speed soon augmented, and they ran down the gradient at a rate of about twenty miles an hour. The station-master being informed of the circumstance, mounted an engine that was at hand, and, accompanied by a driver, stoker, and porter, started off at full speed in pursuit of the fugitives. They advanced a considerable distance before the run-aways could be seen; but, having at length overtaken them, the porter proceeded round to the front of the locomotive and succeeded in hooking it to the wagons. The engine was then reversed, and the trucks stopped and brought back in safety. Had they proceeded much further, it is probable that they would have run on to another line, and must then have encountered an express train which was due from the opposite direction.

The degree of *curvature* that may be given to a railway, in order that it may thread its course through or over the hills, valleys, ravines, morasses, parks, and houses that lie in its route, is a matter of great importance. In some cases curves have been made dangerously or most inconveniently small, so that it has been found necessary to employ extraordinary precautions in passing them; while, in other instances, they have been unnecessarily extended;—and it was only costly experience that could at length determine that "happy medium."

Considerable curves on a main line are always objectionable. This partly arises from the construction of railway carriages, in which, for purposes of security, it is found necessary to fix the wheels to the axles, so as to allow the latter to revolve; and the whole being fitted so as to be rigidly square in all its proportions, such vehicles are essentially adapted for rectilinear motion. A railway-carriage may therefore be said to move in a groove, or in what is equivalent to one; and, without some violence to the principle of its formation, or some strain upon its structure, it is capable of moving only in a straight and direct course. If it has to change its direction, it must be through a curve, which bends so slowly and gradually that the part of it occupied at any moment by the carriage shall not sensibly differ from a straight line. Hence, it is obviously important that curves should be few; and a judicious enginner will so adjust his line that those which are inevitable may be of a sufficient sweep; and it was long considered unadvisable to make them of less than a mile radius; but this estimate has of late been very materially altered.

When the railway system was first projected, great apprehensions were entertained, not only of the resistance which might be produced by curves, but of the danger of passing over them with considerable speed; and Standing Orders were adopted in Parliament, which required that all curves having a less radius than a mile should be the subject of special inquiry. In the course of investigations made by Dr. Lardner, in 1838, he had occasion incidentally to observe the effect of curves upon the resistance; and he found it to be almost infinitely less than had been previously supposed. Curves, having a radius of three-quarters, or even half a mile, did not produce the slightest augmentation of resistance at any speed which the trains attained; and, from observations and experiments which have been made on American railways, where curves of short radius are very common, there is little doubt but that the effect, as ascribed to them, both as to resistance and danger, has been greatly exaggerated.

It is usual, in the construction of curves upon railways, to lay down the outer rail at a somewhat higher elevation than the inner; the effect of which is to make the carriage lean slightly inwards, so that its weight has a tendency to resist the centrifugal force attending the curvilinear motion. An animal spontaneously assumes such a position when moving in a circle; and it will be observed, that the body in such motion will lean inwards, according to the velocity of the motion and the smallness of the circle. The precise elevation of the outer rail must depend upon the radius of the curve, and the average velocity of trains passing over it. If it be raised too much,

the carriage will have an undue pressure on the inner rail; and if too little elevation be allowed, the pressure will be too great on the outer rail. The adaptation cannot, from the circumstances of the case, be absolutely true; but it may be approximated nearly enough for all practical purposes.

Experience has, in many instances, led to the adoption of curves of much smaller dimensions than were formerly allowed. On the Newcastle and Carlisle line there is a succession of curves, the radii of which are very small;* and though some of these are found on steep inclines, yet the line is worked with economy and safety. On the Manchester and Leeds railway are two curves of 220 yards radius, distant from any station, and in a gradient of one in eighty-two, over which the trains have run with security and speed for several years. It is, however, necessary for the engine-drivers to adopt the precaution of shutting off the steam on approaching these spots. Some curvatures, on the other hand, have been found to occasion so much inconvenience by the smallness of their radius that they have been altered; and thus, on the Lancashire and Yorkshire line, at Charleston, the radius of several has been increased from 660 to 2000 feet.

The route of the railway being now in every respect determined,—the deviations, if any, that are permitted by Parliament being arranged,—the work let to the contractors-in-chief, and underlet to subordinates,—the navvies being collected at the various portions ot the line where the "earth-works" have to be made,—and the various officials being prepared to superintend their several departments of labour—the undertaking commences in earnest.

For the successful completion of a work like this, it is indispensable that it should be prosecuted in the most systematic manner; and the men are accordingly employed where they can act with the best effect. Those portions of the line which intervene between cuttings and embankments are first levelled, and rails are laid down; so that the material from the one may be conveyed to form the other,—provision being made, if circumstances permit, that the laden wagons should run by their own velocity down to the embankment; and that only empty ones shall have to be drawn back by means of horses.

A few scores of navvies may now be seen on the face of the hill through which the cutting is to pass; or perhaps bodies of men are at work at each side, between the rows of posts and rails which indicate the route of the intended railway. The upper surface of earth is carted away, it may be, by a neighbouring farmer, who receives it

* Eight chains.

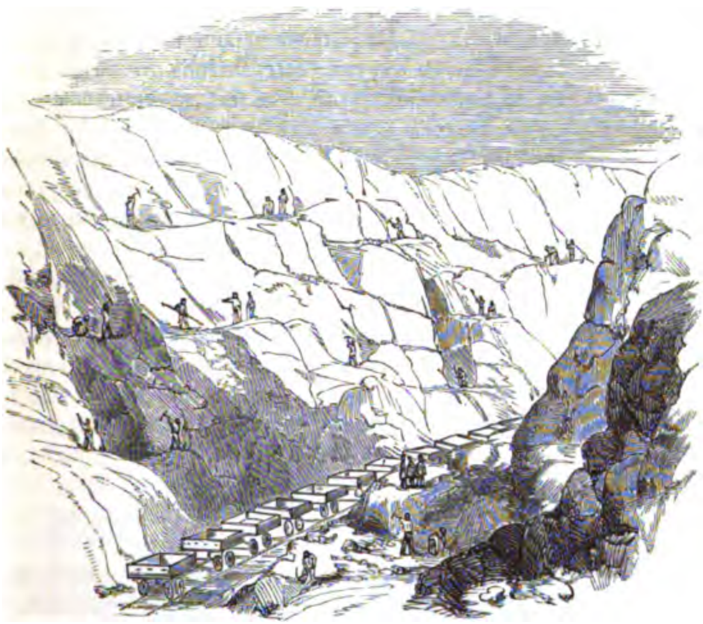
in return for some favour he has conferred on the contractors; and soon the hill is laid open, and a "gullet" excavated. This term is applied to a cutting made just sufficiently large to receive a row of the wagons which are to bear away the earth; and into this the tramway is continued. By the aid of the gullet the wagons can be brought close alongside the material to be moved, and a couple of men being set at work on each, the soil is deposited in them with an ease and celerity far surpassing that which would be required had each spadeful to be conveyed even for the distance of a few yards. Meanwhile, as the *stuff* is removed by the workmen on either hand, the gullet is continued into the hill by those a-head, while lumps are showered into the wagons on all sides. When these are filled, they are secured together in a train, and, if the inclination of the ground permit, it runs down by its own velocity, being regulated by a break-man, who stands on the last wagon, and who applies his feet to a lever when he wishes the train to be stopped. His duty, however, is anything but pleasant, for, what with the roughness of the roads, and the action of the springless vehicle on which he rides, the shaking he receives in his journey seems sufficient to reduce every joint in his body to a most unsatisfactory condition of laxity. On reaching his journey's end he consigns the laden trucks to the embankment men, and assists in driving the horses which have been brought down to convey the empty trucks back.

In the interim a fresh supply of empty wagons has been brought into the cutting, and the men are now filling these as they did the others. When a large number of navvies are employed, the trains of wagons are very numerous, but care is usually taken that the limited room they are obliged to occupy shall not occasion one to retard another. Various sets of rails, according as is most convenient for the work, are laid in different directions; but these arrangements are dependent on circumstances to which our space will not permit us to make further allusion.

A number of other considerations have also to be regarded according to the exigencies of the particular case. In the formation ot cuttings, springs are frequently tapped which discharge large quantities of water, and which must be conveyed away by means of drains; and provision has also to be made that the "vested interests" of neighbouring proprietors are uninjured. Sometimes too, if rainy weather arise, large quantities of water unexpectedly gush from the sides of cuttings, and this has to be turned into temporary channels till permanent drains are constructed for its reception. The excavators are usually paid according to the number of loads that are filled,

though this necessarily depends very materially on the nature of the soil.

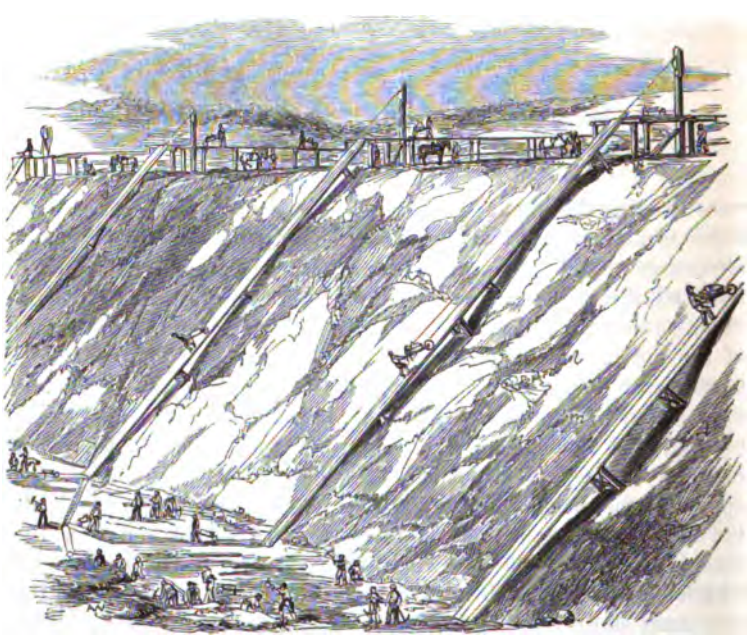
When the stuff has been removed, and the gullet begins to lay reasonable claims to the appellation of a cutting, the rails are moved



MAKING A CUTTING.

so as to bring the wagons immediately alongside the wall of earth on either hand, and thus two trains may be filled at the same time, and afterwards united. Meanwhile barrows laden with earth are trundled from all directions and the contents overturned into the trucks. *Runs*, as they are called, are also made by laying planks up the sides of the cutting, on which barrows may be wheeled. The *running* is performed by stout young men, round the waist of each of whom is a strong belt, fastened to which is a rope running up the side of the cutting, and turning on a wheel at the top, whilst to the other extremity a horse is attached. The barrow being laden by men appointed for that purpose, a signal is given to the driver, who leads the horse quickly out a given distance into the field, and thus the man is drawn up the acclivity; the contents of the barrow are emptied, and the horse being led back the rope is slackened, and the man runs down the plank again, drawing the empty barrow after him.

This practice of running, though common, is dangerous, for the man rather hangs to than supports the barrow, which is at once rendered unmanageable by any irregularity in the motion of the horse. If he finds himself unable to control it, he endeavours, by a sudden jerk, to raise himself erect; then throwing the barrow over one side of the board or "run," he swings himself round and runs back to the bottom. Should both fall on the same side, there is great risk of the barrow with its contents falling on him before he can escape. Although there were from thirty to forty horse-runs in the Tring cutting, which was made in this way, and they were constantly working during many months, and nearly all the labourers were precipitated down the slopes several times; yet from continual practice, such was their sure-footedness, that only one fatal accident occurred. A moving platform was invented by the engineer to supersede the necessity of thus perilling life and limb, but the men, considering it designed to diminish their labour and wages, broke it. The accompanying cut gives a vivid delineation of the process; and when we see the angle at which the ascending stages are laid, it will be imagined that it is not an easy thing for the workmen to maintain



MAKING THE RUNNING.

their "centre of gravity within the base" without considerable experience and coolness of head.

If in the formation of a cutting, more earth is excavated from it than is required for the formation of the neighbouring embankments, it becomes necessary to lay the surplus materials on a piece of land adjoining the line, which is called "putting it to spoil." Where, on the other hand, there is an excess of embanking or deficiency of excavation, it is sometimes necessary to make a cutting out of other land, which is designated side-cutting, for the express purpose of completing the embankment. In both these cases the expense of forming the road is increased to the extent of what is required for the accomplishment of these superfluous operations. There are, however, exceptions. Cases sometimes occur where the distance between the cutting and the embankment is such, that the expense oi conveying the earth from one part of the line to the other is greater than the cost of making a side-cutting from which to form the embankment; and it may be better to deposit the earth from the cutting which ought to have formed the embankment upon waste ground alongside, or of putting it to spoil. These are considerations which are to be left to the judgment of the engineer, and are entirely questions of comparative expense between the one mode and the other.

The cutting being at length reduced to something like its intended proportions, the various arrangements of brick and timber work required for drainage and other purposes are made; while great expense is sometimes unavoidably incurred in giving to the sides of the cutting the inclination which is necessary for their stability, an adequate knowledge of which can only be acquired by considerable experience in this department of science.

The importance of avoiding the trouble, danger, and cost of accidents from slips in cuttings is obvious; and much laborious and patient investigation has been given to the subject. The degree of the inclination required by the sides of cuttings or embankments depends on the nature of the strata of which they are composed. All materials have a certain position at which they will rest, which is denominated the *angle of repose*, and in the strata through which railway cuttings are made, and from which embankments are usually formed, the slopes of the sides are usually about a foot and a half horizontal to one foot vertical, and from this they vary to two feet horizontal to one vertical. Chalk has usually great stability. This is illustrated in the town of Dover, a considerable portion of which lies beneath a high range of chalk cliffs, and yet has long been perfectly secure. On the other hand, it is sometimes very insecure and thin. In the well-known

Merstham cutting on the Brighton line, which passes through stratified chalk, the sides of which are nearly perpendicular, there is a constant falling away of pieces which renders the attendance of watchers by night and day indispensable. This is especially the case in frosty weather, when the jutting pieces begin to give way, and after a while many of them come tumbling down. Their rattling and crumbling, however, give notice to the workmen that they may prepare to remove the fragments, and thus they are enabled to provide against accident to passing trains.

When cuttings are formed through rocky strata, no considerable inclination is required, as is seen in the case of the stone cutting which forms so interesting a feature of the London and Birmingham line between the Wolverton and Blisworth stations. The Olive Mount cutting, on the Liverpool and Manchester Railway, is in some parts more than a hundred feet deep. It is indeed a ravine cut in the solid rock, and 480,000 cubic yards of stone were removed in its excavation. In such instances tunnelling would generally be less expensive, but in this case the material was required for the formation of an embankment in the vicinity. So small is the sacrifice of land, and the amount of superflous material necessary to be removed when there is no angle of repose, that cuttings through clay, gravel, or other loose substances are nearly as expensive as those made in the solid rock.

Other materials require different degrees of inclination to give them the desired stability. Thus the London clay has been made to stand at one to one, and has slipped at one to three, its firmness depending greatly on its dryness when cut through, or, in the case of embankments, when it is tipped. If it contains much water, it is peculiarly difficult to manage; and in the cutting which extends for some distance between the Euston and Camden stations, the clay is only retained in its position by walls seven bricks in thickness at the foundation, and three at the top; they are twenty feet in height. They are also curved inwards to give them additional security. The walls by themselves, however, were insufficient to sustain the pressure; and it was found necessary to support them by no fewer than forty-four massive iron beams, which stretch across over head, and provide a counterpoising lateral pressure.

Another illustration of the difficulties which have occurred in working the London clay may also be mentioned. In the formation of a cutting on the Birmingham Railway at Highgate, near what is now called the Archway-road, a gullet had been formed and a temporary tramway laid down. Excessive wetness set in, but the works were

continued with persevering energy, when one morning the treacherous material gave way, the gullet was filled up, and the labour of weeks, estimated at a cost of £800, was destroyed by an accident which could not have been anticipated. Sometimes the work is made secure with comparative ease. Thus, in all the excavations on the Newcastle and Carlisle line, through a district sixty-two miles in length, the slopes are made at one and a half to one, and they have been found to stand well. The sand cutting through the Cowran Hills, on that line, is 110 feet deep, and it is interspersed in some places with thin layers of clay, and yet it has remained firm with a slope of one and a half to one.

Embankments are generally made with the same slope as that of the excavations; and it is presumed, that with whatever slope the excavation will stand, the embankment formed of the material from such excavation will be similar. In some of these cases no small trial has been made of the ingenuity of the engineer; and it may be regarded as a general rule, that where the land can be procured at anything like a fair price, ample width should be allowed both to embankments and cuttings.

Further illustrations of the difficulties of these works may be given. In the formation of a cutting on one of the railways in the north of England, it was estimated that about 50,000 cubic yards of earth would have to be removed. The computation was unexpectedly shown to be fallacious. It appeared that the soft earth was supported by a seam of shale, which was no sooner severed than a mass of earth slipped down into the railway, which required the removal of no less than 500,000 cubic yards of material. In the construction of another cutting, it was found on the surface of the rock through which it passed, that there lay a stratum of about twenty feet of clay, of so slippery a nature, that for a considerable time, despite every precaution, it flowed into the cutting "like porridge;" and the only remedy that could be devised was to remove the stratum to a considerable distance, terminating it by a slope at a very flat angle.

The Haslingden Cutting, on the East Lancashire line, was probably one of the most difficult works of the kind which have been undertaken. Nearly half a million yards of peat, gravel, and sand were removed from it, and it had to be cut through a bog-hole, the material of which, being saturated with water, sometimes came in faster than it could be removed. The peat was here twenty feet or more in thickness; and some idea may be formed of the effort required to overcome the difficulty, when it is stated, that in the

summer of 1848 all the earth which two locomotives and their trains of wagons could bring to the spot during three months was emptied into it without obtaining a foundation. The obstacle was at length surmounted by the Company's engineer, Mr. Perring, who sunk large masses of stone at the required points, which, forcing away the peat, served as a solid basis over which the line could pass.

The Blisworth Cutting was a great undertaking. It passes through limestone and clay, and upwards of 1,000,000 cubic yards of earth had to be removed in its formation, about a third of which was limestone, of a texture nearly as hard as flint. More than 800 stonemasons, miners, labourers, and boys were at work at this spot, directed by experienced engineers, and aided by horse and steam-power, with "all appliances and means to boot." In effecting the work, 3000 barrels of gunpowder are stated to have been employed in blasting. The cost of the work was about a quarter of a million of pounds sterling.

The largest cutting on the London and Birmingham line is at Tring. It passes through chalk without flint for nearly two miles and a half, and is crossed by three bridges of three arches, besides a smaller bridge. Its average depth is forty feet, in some parts as much as sixty, and 1,400,000 cubic yards of chalk were removed in its excavation.

The difficulties connected with cuttings do not, however, always terminate when they are first completed. In many instances their sides have stood securely for weeks, months, or years after they were constructed, and have afterwards loosened and fallen. The accident has usually arisen from the accumulation of water behind them, or from the imperfect drainage of the adjoining lands. This water, resting on the top of the embankment, disturbs it, by the moisture and the pressure; and the alternate expansion and contraction of the superior strata by the summer's heat and the winter's cold, occasion a general movement towards the opening left by the cutting, that being the direction of the least resistance. In one instance, a large quantity of iron pyrites and carbonate of lime mingled together and caused a mutual decomposition, which induced the formation of crystallised sulphate of lime. This led to the expansion of the bank: water percolated through the clay strata on which it rested, and the stability of the whole mass was impaired. In wet weather, too, springs arise where they have not been expected, and sometimes saturate the entire bank without being observed. In the Bushey Cutting, on the London and Birmingham line, several springs have for a long time forced their way from within; and when the writer visited

the spot in the summer, the ground was soft and marshy. In some cases it has been found necessary to make open drains, running in a diagonal manner, across the slope, to carry off the water to a drain on either side the bottom of the cutting. In others, instead of the slopes being uniformly flat, they have been made to assume a curve, having the most inclination at the bottom, where there is the greatest pressure, and the least inclination at the top, where the weight is comparatively small. The thorough drainage of cuttings of magnitude is of great importance, and improved methods have been suggested by which this may be accomplished by means of gravel counterfort and bending, which have been found very useful.

WOODHOUSE TOWER AND CUTTING, ON THE CALEDONIAN RAILWAY.

In the winter of 1841 and 1842, some land-slips took place in the New Cross Cutting of the Croydon line, which sufficiently illustrate the importance of their prevention. The cutting is eighty feet deep

in the highest part, and in the autumn about 50,000 cubic yards of earth suddenly gave way from the western slope, and overwhelmed the line of railway immediately after the passing of a train, covering both lines of rails to a depth of nearly 12 feet and for a length of 360 feet. Other slips subsequently occurred at the same spot as well as at the eastern slope, and upwards of 250,000 cubic yards of earth had to be removed. The works were carried on without intermission both by day and night, but it required three months before the trains could proceed as before.

On all the modern railways the slopes are covered with a layer of soil, which is procured from the base of the embankments, or from the top of the cuttings, and this is spread over the face of the slope about six inches in thickness, or as thick as the amount of soil from those places will yield. It is of great importance to the security of the slopes, that the soil should be laid on as soon as possible after the excavation is made, or the embankment is consolidated, and that it should be either sown with grass or clover, or both, in order to have a turf upon it before the slopes are affected by the action of the weather. By attending to these considerations, slopes will often stand where, under other circumstances, from the action of the weather, they would crumble away.

CHAPTER VI.

Levelling of the Round Down Cliff near Folkestone—Blasting on the Londonderry and Coleraine Railway—Embankments—The Tip—Formation of an Embankment—Disappearance of an Embankment—Embanking across Marshes—Embankment over the Stratford Marshes on the Eastern Counties Line—Embankment at Ashton—Embankment at Morden Carr, near Darlington—Embankment across Chat Moss—Extraordinary Difficulties of the Undertaking—Process of Draining and Solidifying Marshes—Embankment on the Londonderry and Coleraine Railway—A Baked Embankment—Earth-works of Railways—Comparison of the Labours of the Ancients and Moderns—Navigators—The Early Navvies—Characteristics of Navvies—Shrewdness of Navvies—Recklessness of Navvies—Coolness of Navvies—Daring of Navvies—Illustrations—How to manage Navvies—Anecdotes—Sub-letting of Work—The Truck System—Moral Condition of Navvies—A Contrast—Condition of Navvies—Children of Navvies—Samuel Morton Peto, the Navvies' Friend.

N the ever-varying exigencies which arise in the formation of a railway, abundant opportunities are afforded for testing the skill and experience of the engineer. An illustration of this is furnished in the case of the South Eastern line, which is worthy of special consideration. Towards the west, in the direction of Folkestone, the line of sea-face is terminated by Abbot's Cliff, and to the east, adjoining Dover, by the well-known Shakspeare's Cliff. These hills are separated from the main heights by a narrow valley, ascending from which they slope upwards by gentle courses to their escarpment, which presents to the ocean a majestic front of about five miles in extent, and an average height of 350 feet. This front is nearly perpendicular, but is varied by occasional bold projections, which divide the beach at their base into corresponding spaces. One of these protruding rocks was the Round Down Cliff: it rose to the height of 375 feet above the level of the sea, being the highest point of the celebrated range of chalk cliffs which runs from Folkestone to Dover. How, then, was

a passage for the railway to be made in a direct line to Shakspeare's Cliff? To tunnel it was impossible, if such a word is found in the vocabulary of the engineer of the present day; to dig it down would have occasioned a delay of twelve months, and an expense of £10,000. The engineer of the line, Mr. William Cubitt, conceived a method of accomplishing the desired work, although the obstacle to be removed was nothing less than a mass of chalk rock, 300 feet in length, but of still greater height, and averaging 70 feet in thickness. This was by the explosion of 19,000 pounds of gunpowder, and by the aid of galvanism.

ABBOT'S CLIFF TUNNEL.

At the time appointed for the blasting, a number of distinguished visitors reached the Downs, and joined the Directors and the scientific corps, at a commodious pavilion erected near the edge of the cliff, at a distance of about a quarter of a mile from the point of

explosion. When the arrangements were completed, and the spectators assembled, curiosity was at its height, and the most strange and fearful speculations were entertained by the people assembled as to the possible contingencies which might arise. "What," said Professor Sedgwick—"what if there should be a concealed fissure—a blinded chasm—in the cliff behind us? A smart vibration *might* throw it open." "What then?" inquired a ghastly querist. "We shall be swallowed up!" muttered one in response; while another sighed, "We shall be swallowed *down!*" Still the fascination was irresistible, and though many were uneasy, and wished to be gone, no one withdrew. After a long suspense of half-an-hour the discharge of half-a-dozen blasts on the face of Abbot's Cliff occasioned a great sensation. When two o'clock arrived, the time appointed for the explosion, the interest which pervaded the multitude became most intense. The "choughs and crows that winged the mid-way air" were distinctly heard amidst the profound calm that prevailed. The signal which announced it to be fifteen minutes before firing having been given, all the other flags were hoisted. The air was still, the sea was calm, and the murmuring surges gently laved the cliff's huge base. A quarter of an hour now passed, and a shell with a lighted fusee was thrown over the cliff, from which it bounded to the beach, where it burst with an astounding report, followed by echoes from the hills, which had the effect of sharp fusillades of musketry. The flags were then hauled down, and at length the "one minute before firing" arrived. The excitement of the people was now painfully intense, while their courage was put to its severest test. "Now! now!" shouted the eager multitude, and a dull, muffled, booming sound was heard, accompanied for a moment by a heavy jolting movement of the earth, which caused the knees to smite. The wires had been fired. In an instant the bottom of the cliff appeared to dissolve, and to form by its melting elements a hurried sea-borne stream. The superincumbent mass, to the extent of about five hundred feet, was then observed to separate from the main land, and as the dissolution of its base was accomplished it gradually sank to the beach. In two minutes its dispersion was complete. The huge volleys of ejected chalk, as they swelled the lava-like stream, appeared to roll inwards upon themselves, crushing their integral blocks, and then to return to the surface in smaller and coalescing forms. The mass seemed to ferment under the influence of an unseen, but uncontrollable power. There was no roaring explosion, no bursting out of fire, and, what is very remarkable, not a single wreath of smoke; for the mighty agent

had done its work under an amount of pressure which almost matched its energies: the pent-up fires were restrained in their intensity till all smoke was consumed. A million tons of weight and a million tons of cohesion held them in check. When the turf at the top of the cliff was launched to the level of the beach, the stream of *débris* extended a distance of 1200 feet, and covered a space of more than fifteen acres!

The moment the headlong course of the chalk had ceased, and the hopes of the spectators were realised, a simultaneous cry arose of "Three cheers for the engineer!" and William Cubitt was honoured with a hearty huzza from the lips of a grateful people. An era in the history of engineering had passed; a precedent had been established, the results of which none could anticipate. It had been demonstrated that the most powerful and mysterious agency in nature was under computable regulations, and in no small degree under the control of science. The congratulations thus re-echoed were borne to the gloom of the battery-house, and at once dissipated the apprehensions of the operators; for so slight was the noise and the shock, that the impression made on their minds was that the experiment had failed, for their situation prevented their witnessing the result. The ruins of the Round Down Cliff may now be observed stretching towards the sea at the mouth of the Shakspeare tunnel. "Nothing," says Sir John Herschel, "can place in a more signal light the exactness of calculation which could enable the eminent engineer by whom the whole arrangements are understood to have been made, so completely to task to its utmost every pound of power employed as to exhaust its whole effort in useful work—leaving no superfluous power to be wasted in the production of useless uproar or mischievous dispersion, and thus saving at a blow not less than £7000 to the railway Company!"

A similar blasting, on a small scale, was made on the Londonderry and Coleraine line. It having been found necessary to hurry on the works, it was determined to throw a hill into the sea, through which a tunnel had been commenced. This took place in June, 1846. A heading or gallery was formed in the rock from the side of the cliff, fifty feet in length, at the end of which a shaft was sunk, for twenty-two feet, to the level of the railway, and again another gallery was made at the bottom, running at right angles to the first, and further into the rock. At the end of this was placed 2400 pounds of powder, and the earth was well filled in, the wires for the passage of the electric fluid being carefully arranged. The smaller charge of 600 pounds was then placed higher up in the rock. On the

explosion being made, the bottom of the mass was seen to heave outwards for a moment, trembling with the force exerted on it, and then, cracking into a thousand fissures, it rolled into the sea below. The amount of material removed was upwards of 30,000 tons. The contractors afterwards entertained 500 ladies and gentlemen in one of the tunnels, which had been tastefully fitted up as a banqueting-room, and lighted by a row of magnificent chandeliers, bearing 350 candles, and by 1200 variegated lamps.

MAKING AN EMBANKMENT.

When the level of a railway has to be raised above the natural surface of the ground, it is usually done by the formation of a mound of earth with sloping sides, which bears the line at its summit, and is called an embankment. The material of which this is formed is generally obtained from some neighbouring cutting;—the engineer, in laying out the railway, having so arranged that the embankments shall be adequately supplied from thence. If there be not enough from these sources, it is procured from an excavation

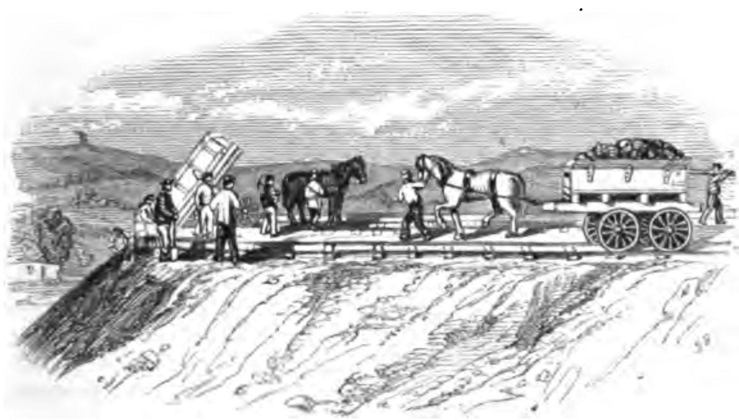
made as nearly as is practicable at the point at which it is required. This is called a "side-cutting," and is usually formed in a hill, so that the material may not have to be raised to a level with the line. The distance along which this is conveyed from the cutting to the point at which it has to be deposited is called "the lead;" and where a very long and low embankment occurs, it may happen that the expense of "drawing" the "stuff" would be so great, as to render it cheaper to form it from a side-cutting. These considerations, however, can only be determined by the circumstances of the particular case, with special reference to the price of land and labour.

The material is conveyed along the lead by different means. If possible, as has been mentioned, the loaded wagons are made to run down the tram-road, by their own gravity, to the embankment. In some instances, each load has to be drawn along the lead by horses, while in other cases this duty is performed by engines, which are conveyed to the scene of operations on what is called a "drug." To convey so weighty and cumbrous an affair as a locomotive along a common road, is not a trifling matter, especially if the distance it has to travel be considerable, and many hills intervene. Comparatively light engines are usually employed for these purposes, but the mounting of them on the drugs, the conveyance of them from place to place on the route, and the "launching" of the iron monster at last, are incidents by no means devoid of interest. Then may the old turnpike-road be seen invaded by a team of sixteen or eighteen contractors' horses, each pair under the guidance of an appointed driver; while the gleaming brass-work, the black funnel, and the metal ribs of the engine, form a striking contrast to the rural beauty, simplicity, and tranquillity which are so characteristic of our landscape scenery.

In the formation of an embankment, it is of much importance that it should be constructed with great firmness, and with due consideration of the nature of the material of which it is composed, and the probable weight which it is destined to support. It must also be of sufficient width, including the "allowance for settling;" for it is usually both difficult and dangerous to make any subsequent additions to embankments, in consequence of their liability to slip.

As most of our readers have probably witnessed the operation of *tipping*, by which the contents of the loaded wagons are discharged in the formation of an embankment, a brief allusion to the process will here suffice. An embankment is sometimes commenced from two directions, which at last unite in the middle, the material being furnished from cuttings at the different sides. A train of wagons

being brought on to the part already finished, preparations are made to empty them. A tram-road has already been formed to the edge of the embankment, and at its extreme verge a stout piece of timber is secured, to prevent the wagons being precipitated over it when their contents are discharged. One of the trucks is then detached from the train, and being brought within a few hundred yards of the end of the embankment, the horse that draws it is made to quicken his speed, and then to trot and gallop, so as to give the required impetus to his load. The uninitiated observer fancies at the moment that both horse and driver must be killed, or hurled over the embankment; but when they have approached very near to the edge, the driver loosens the horse from the wagon, gives him a signal which he has been taught to obey, and both leap aside at the same instant, with the greatest celerity; while the wagon rushes on by the speed it has acquired, till it is suddenly stopped at the end of the embankment by the piece of timber: the shock makes the hinder part to tip up, and the load is discharged in the manner shown in the Engraving. The horse is immediately brought up again, hooked on,



THE "TIP."

the truck rights itself, and is drawn away to form part of the empty train which will soon return to the cutting. If the works of the railway are proceeding with moderate rapidity, two lines of rails, and two or three sets of wagons, horses, and men, are at work at the same time. Should the material thus discharged not be in exactly the required position, the spades of the navvies do the rest before it is allowed to settle. Great care is of course necessary that the elevation of the embankment be rightly adjusted; and this is aided

by the erection of posts at intervals along the line, which are fitted with cross pieces to indicate the exact height which is to be preserved.

When the general outline of the embankment has thus been given, it is trimmed so as to have the required uniformity of appearance. If there are hollows to be filled up after the settling, the material is brought from the *parings* at the top, or wherever there may be a redundancy. This is conveyed to the spot where it may be wanted, in little three-wheeled carts, the contents of which are tipped over the side, and then spread with the spade.

The faces of both cuttings and embankments are afterwards covered with soil to the depth of about a foot, and the grass which springs up gives it a further security against slips. It has been proposed to plant these slopes with larches, which, it is thought, would furnish a supply of sleepers from time to time, and also return a profit from the thinnings, which might be sold for poles; while some have advocated the growth of hops on the lines in the south of England. It is, however, important that the ventilation of the road should not be impaired, and Companies have been content to let out the grass on their embankments which are of sufficient slope for hay-ground.

As an illustration of the unexpected difficulties that sometimes arise in the prosecution of great engineering works, it may be mentioned, that on one occasion an embankment was observed gradually to sink without any apparent cause, and at length the adjoining fields began to rise, the superincumbent mass having penetrated some less solid stratum below, and by expanding at its base, had elevated, without otherwise disturbing, the adjoining surface. It was also asserted, though we will not venture to endorse the evidence, that an embankment which had been constructed on a railway in North America, suddenly disappeared from view, and was found to have sunk in sixty feet of water. The cause of this was ascribed to the fact that an extensive lake had in the course of ages been covered with various deposits, which at length formed a soil of sufficient stability to withstand the operations of agriculture without giving way; but being oppressed by the weight of so extraordinary a contrivance as a railway embankment, it declined to be thus burdened, and deposited its load beneath its waters.

The embankment of the Eastern Counties line which crosses the Stratford Marshes has a peculiarity which is worthy of notice. In order to facilitate its construction, by enabling the workmen to tip more wagons than usual in a given time, Mr. Braithwaite constructed a kind of scaffolding or stage in advance of the end of the embank-

ment; and by leaving some of the timber framework of the scaffolding in the earth of the embankment, it is so bound together as to enable it to stand against the action of the heavy floods to which the valley of the Lea is subject, far better than if it had been constructed in the ordinary way.

Other difficulties have arisen in the formation of embankments across marshy districts, which are very curious. Thus it was found that in the completion of one at Ashton, the materials disappeared as fast as they were deposited, owing to the unsound state of the valley at the base; and the surrounding surface outside the railway actually burst, in consequence of the enormous pressure, and a culvert near the spot was completely destroyed. The power of a culvert to sustain an embankment fifty feet in height may be supposed to be great; but its construction upon a soft foundation is a task upon which no engineer, however cautious and skilful, can calculate with certainty.

Nor is it only in the formation, but in the working of lines across marshes, that accidents have arisen. Of this an illustration was given in the case of a portion of the Newcastle and Darlington line, which traverses a spot called Morden Carr, about eight miles north of Darlington. The soil consists of peat, and is of great depth, being considered the remains of a primæval forest; while, from its low position, compared with the surrounding hilly country, it has in winter presented the appearance of an immense lake. At such periods the line has been completely overflowed, and sometimes to such a depth as almost to extinguish the engine fires. On one occasion, a portion, to the extent of between fifty and sixty yards, gave way, and it was found necessary to transfer the passengers and luggage across the obstruction, to other trains. Meanwhile, a great number of workmen were collected to repair the injury, but the continuance of incessant rain reduced the ground to such a state, that as ballast was laid upon the depressed part, the additional weight only caused a further sinking, and rendered the whole attempt abortive. Under these circumstances a temporary way had to be constructed, which avoided the marshes, and united the sound portions of the line, and it was with great difficulty that the line was restored to a condition for safe and efficient working.

Various other illustrations may be furnished of the obstacles which have arisen in the formation of railways over marshy ground. One of the most important of these was the traversing of Chat Moss by the Liverpool and Manchester line. This spot was indeed nothing less than "a huge bog," of soft or flowing moss, stretching

over an area of twelve square miles, a large portion of which was from twenty to forty feet in depth, and estimated to contain at least sixty million tons of vegetable matter, of so pulpy a nature that cattle could not walk on it, and in many parts a piece of iron sank into it by its own weight. It will readily be imagined that to traverse this place with an embankment and a secure road, was no small undertaking; and when the railway was under discussion, an eminent opposing engineer declared "that no man in his senses would attempt a railway over Chat Moss;" and he affirmed that it would cost not less than £227,000. This "impracticable" undertaking was ultimately and most successfully completed at an expense of £40,000, by means to which we may briefly advert.

In order to deprive the moss of some of its water, its drainage was commenced, and an embankment raised of about twenty feet above the natural level of the eastern border. The weight of this mass pressed down the moss, and many thousand cubic yards gradually disappeared beneath the surface; but the work was at length completed. An embankment was then formed on the western side, nearly a mile in length, and fourteen to twenty feet in height, having an inclination of rather less than forty-five degrees; and this was found to give it the greatest security.

There is another moss of considerably less extent over which the railway had to pass, and which, at one end, was terminated by an extensive cutting of clay and gravel. As an embankment of four feet high had to be formed over it, the materials from the excavation were used for this purpose. The moss was about twenty feet deep, and it was soon found that, as the materials were successively laid upon it, the whole mass gradually sank; and when the embankment was finished, although the actual level of the railway was only four or five feet above the original surface, the quantity of the earth deposited would have made on ordinary ground an embankment twenty-four or twenty-five feet high. With such materials, therefore, as clay and gravel, it would have been impracticable to have formed an embankment over Chat Moss, for the quantity required and the expense involved would have been enormous. Mr. Stephenson accordingly laid drains on each side of the line, and also lateral ones, where necessary, to carry off the water. By these means a certain depth of moss on the top was partially consolidated, and formed a layer or surface of dry moss, of considerable tenacity; upon this hurdles nine feet long and four broad, and wickered with heath, were laid down transversely. In many places only one layer of hurdles was required; but where the moss was very soft, two were used.

Upon this about two feet of gravel or ballast was placed to form the permanent road; and wooden sleepers, stretching across each line of road, were employed, on which the rails were laid. The stability of the road depended, therefore, upon the tenacity of the materials, supported by the buoyancy of the moss. When we consider the area of base thus firmly bound together, and the support which even so spongy a substance as the moss must give to so extensive a platform, it was natural to suppose that the impression made upon a large area, by the pressure of so inconsiderable a proportion of the whole weight as that of a train of carriages, must be very slight indeed; and experience has fully proved the stability of the road.*

It is worthy of remark, that the late Mr. Roscoe expended large sums in attempting to drain the very morass now traversed by the railway; but, after enormous outlay, the undertaking was found to be unprofitable. It is at present, however, in the highest state of cultivation, and has produced some of the largest turnip crops in England. This extraordinary change partly arises from the facilities which have been afforded by the railway for obtaining cheap supplies of soil, and by its giving easy access to a good market for the produce.

These are not the only instances of successful undertakings of this kind, for the South Devon Railway traverses the once unfathomable swamp of Cockwood.

A remarkable embankment has been raised on the Londonderry and Coleraine Railway. It not only serves the ordinary purpose of such a work, but it acts as an embankment to reclaim 22,000 acres from the sea, at Lough Foyle. This is a large lough on the northern coast of Ireland, covering an area of about 60,000 acres, in which the tide did not usually rise more than six feet, while at low water a large part of it was perfectly dry, exposing an expanse of rich alluvial deposit. Of the reclaimed land, 12,000 acres are set apart to cover the expenditure of the railway, and these have been gradually inclosed and sold.

Difficulties have sometimes arisen in the construction of railway works against which no provision could have been made. The Wolverhampton Embankment had been almost completed, when it was observed to display certain unaccountable volcanic indications. It first began to smoke, and then became exceedingly hot, while a slow, smouldering flame might at night be seen to rise from it. The people in the neighbourhood were filled with alarm: by some it was confidently affirmed that the embankment would certainly blow up; and one old lady reminded her friends of the opinion she had

* A Practical Treatise on Railroads. By Nicholas Wood.

uniformly entertained during the progress of the railway—that "the devil was at the bottom of it!" The embankment having for some time carried on this freak of spontaneous combustion, and having burned the sleepers, at last exhausted itself; and it was found that the phenomenon had been occasioned by a large quantity of sulphuret of iron, or pyrites, contained in the earth.

The earth-works of a railway, as the cuttings, levellings, and embankments are denominated, are frequently enormous. In lines which traverse comparatively even districts of the country, they are small and unimportant; but in others the case is very different. According to the estimate laid before the Parliamentary Committee by the engineer of the South Western Railway, it was computed that the aggregate amount of earth-work would be about 16,000,000 cubic yards, which give an average of 200,000 cubic yards a mile. Almost every portion of the London and Birmingham line consists of embankments or cuttings; so that by the original section the latter were estimated at about 12,000,000, and the embankments at more than 10,000,000 cubic yards.

Mr. Lecount has made some interesting calculations, illustrative of the labour involved in the formation of the earth-works of the London and Birmingham Railway. On its completion, he affirmed that it was the greatest public work ever executed either in ancient or modern times. "If we estimate its importance," he says, "by the labour alone which has been expended on it, perhaps the great Chinese wall might compete with it; but when we consider the great outlay of capital which it has required, the great and varied talents which have been in a constant state of requisition during the whole of its progress, together with the unprecedented engineering difficulties, which we are happy to say are now overcome, the gigantic work of the Chinese sinks wholly into the shade."

He proceeds to institute an ingenious comparison between that railway and the great Pyramid of Egypt, in order to illustrate the magnitude of the undertaking:—"After making the necessary allowances for the foundations, galleries, &c., and reducing the whole to one uniform denomination, it will be found that the labour expended on the great Pyramid was equivalent to lifting 15,733,000,000 cubic feet of stone one foot high. This labour was performed, according to Diodorus Siculus, by 300,000 men; according to Herodotus, by 100,000 men; and it required for its execution twenty years. If we reduce in the same manner to one common denomination, the labour expended in constructing the London and Birmingham Railway, the result is 25,000,000,000 cubic feet of material (reduced to the

same weight as that used in constructing the Pyramid) lifted one foot high, or 9,267,000,000 cubic feet more than were lifted one foot high in the construction of the Pyramid; yet this immense undertaking has been performed by about twenty thousand men, in less than five years.

"From the above calculation have been omitted all the tunneling, culverts, drains, ballasting and fencing, and all the heavy work at the various stations, and also the labour expended on engines, carriages, wagons, &c.: these are set off against the labour of drawing the materials of the Pyramid from the quarries to the spot where they were to be used—a much larger allowance than is necessary.

"As another means of comparison, let us take the cost of the railway, and turn it into pence, and allowing each penny to be one inch and $\frac{34}{100}$ths wide, it will be found that these pence, laid together so that they all touch, would more than form a continuous band round the earth at the equator.

"As a third mode of viewing the magnitude of this work, let us take the circumference of the earth in round numbers, at 130,000,000 feet. Then, as there are about 400,000,000 cubic feet of earth to be moved in the railway, we see that this quantity of material alone, without looking to anything else, would, if spread in a band one foot high and one foot broad, more than three times encompass the earth at the equator."

Having thus far considered the method and means in the formation of a railway, it will not be irrelevant to make brief allusion to the class of men by whom these works are accomplished, and as the result of whose labours we are possessed of the advantages of railway travelling.

The "navvies" of Britain are distinguished by extraordinary power and hardihood of body, and energy, perseverance, and courage of mind. The men first employed in the construction of railways formed a peculiar and distinct section of the community, being collected from the "bankers" of the lowlands of Lincolnshire and Cambridgeshire, who had been engaged in the recovery of waste lands from the sea, in the drainage of the fens, or in the formation of canals and docks. The increasing requirements of railway construction, however, drew great numbers of men, by the attraction of high wages, from all parts of the country, and especially from the hills of Lancashire and Yorkshire, who were characterised by the boldest peculiarities of the Anglo-Saxon stock. These were soon mingled with a host of miscellaneous workmen. Many a sturdy labourer, who had involved himself in debt in his native village, or had com-

mitted some petty breach of the peace, sought refuge and employment on a neighbouring line; while a considerable number of Irishmen were glad to exchange the beggary and starvation of "the emerald isle," for the comparative wealth of the Saxon railway. Multitudes of navvies were thus employed in various parts of the country; and when one portion of a line was completed, the men found little difficulty in obtaining similar employment elsewhere. An idea may be formed of the numbers thus engaged, from the fact, that on the small line from Ely to Peterborough alone, there were at one time 3400 men employed, besides 700 wagons and 286 horses; and on the Irish Southern and Western Railway, no fewer than 25,000 workmen were long engaged. The navvies are in general of fine physical structure, and frequently manifest more courage than is to be found among any other race on the surface of the globe; to which is often superadded a cunning, which appears as characteristic of the race as shrewdness is of the Scot, and wit of the native of the sister isle.

Of their extreme recklessness, as regards life or limb, numerous illustrations might be furnished. Thus, in the formation of the Kilsby tunnel, two or three of the workmen were killed in trying to jump one after another across the mouth of the shafts, in a *game* ot "Follow my Leader." When the Blisworth cutting was in course of excavation, and the material from thence was taken to the Wolverton embankment, the men were accustomed to ride down on the tip-wagons to their dinners; in doing this, great danger was incurred, for the wagons not unfrequently got off the rails, and their contents of workmen and stone were at once precipitated in a heterogeneous mass upon the ground. On one of these occasions, though but a few days after a fatal accident of a similar nature had taken place, some wagons were thrown off the rails, and several men buried beneath the limestone. One stalwart fellow scrambled out from the heap, and feeling his arm, said to a more fortunate comrade—"It's broke, I maun go home;" and, having waited only to ascertain the fate of his fellow-sufferers, he strode off to his dwelling, which was six miles distant, supporting the broken limb with the sound one.

A fine handsome youth, who by the same accident had his foot crushed into a shapeless mass of flesh and bone, gave vent to his feelings by crying bitterly. A rough-looking ganger who stood by, took the pipe from his lips, and in a blunt, advising way, said to the boy—"Crying 'ill do thee no good, lad;" and then, as if somewhat acquainted with the mysteries of the scalpel, added, "thou'dst better have it cut off above the knee."

The following is an illustration of the extreme coolness and daring of these men. A workman employed on the Scottish Central Railway, had lighted the fusees connected with some charges of gunpowder by which a blast was to be effected, and having given the signal to be drawn up, the rope slipped, and the poor fellow was suspended but a few feet above the spot where the explosion was about to take place, and having before him the prospect of instant death. His presence of mind, however, did not forsake him. He called out that he might be lowered again, and then approaching the burning fusees, he extinguished them one after another, and his life was saved. On examination, they were found to have burned within half an inch of the powder!

It may be easily conceived that the management of large bodies of such men was no easy task to those on whom it devolved. Yet it has been found that a little tact and wit would ordinarily suffice, if judiciously employed, in guiding and subduing them, when any attempt at force would have been fatal either to the one party or the other. A bold demeanour, a few words of advice well applied, connected with a kind interest in them, almost invariably commanded their respect and obedience. We will relate a few anecdotes illustrative of this.

A huge rough navvy came on one occasion to an assistant engineer of one of the western lines with whom the writer is acquainted, and, evidently greatly excited by some injury he had suffered, concluded his complaint by the blunt and angry inquiry whether such treatment "was not enough to raise any body's temper." Our friend availed himself of the word, and replied by asking, with the inquiring air of a person who had heard for the first time of such a thing as "a temper," or, as if he thought it was a savage animal which was dangerous to society and to himself, asked; "Temper—temper? What 's that? Do you mean to say you keep a temper?"

The navvy was not apt at a definition, and wondering at seeing his master "make great eyes," as the Germans say, was silent.

"Do you mean to say," continued the engineer, "that you keep a temper? I know *I* don't, for I can't afford it,—and so I always leave it at home in the morning before I come to work, or it would be always getting me into trouble."

The navvy, received thus quietly, was evidently fast cooling, and at length replied, "Well, sir, I suppose it 's no use saying nothing, for if *you* can't afford to get out of temper, I suppose *I* can't;" and he quietly and respectfully trudged off to his work.

On another occasion the resident engineer on one portion of the

Great Western Railway was engaged in some professional duties at his residence on the Saturday afternoon, when a messenger arrived in breathless haste from the line, and stated that the men had all been greatly enraged in consequence of some matter relating to their pay, and that they had left their work, and were coming down *en masse* to the village. "Bring a horse," said the engineer; and in a few minutes he galloped up to the scene of action, and met the whole gang, to the number of about three hundred, crossing the field with their tools on their shoulders. They were evidently extremely angry, and manifested their rage by the most terrible oaths and threats. Decisive measures were requisite; but where no force could have stayed them, a little prompt management answered every purpose. The engineer rode into the midst of them, and throwing the reins on the back of his horse, he exclaimed, in a voice which all could hear: "What are you doing here? And what is the use of your coming to complain to me? You know I have nothing to do with your pay; I have only to see you do your work well. And you know that I am always your friend if you are in the right; but you are not now, so go back and mind your work. And mark," added he, "if there is any row, or one drop of blood spilt, I shall know that you, and you (singling out two or three of them), are the ringleaders!" The men knew their master, and turned back, like a flock of sheep, to the line; yet it was only such a decisive and judicious course that kept that mass of men from one of those scenes of rage, drunkenness, fighting, and debauchery, which made them, in many cases, a terror to the people of the neighbourhood. But when once excited by liquor it was useless to attempt to restrain them, for this would only have increased their violence; the engineers never stopped then to parley with them, but as they passed along the roads on horseback, where the men might be standing in the way, an authoritative "Whar off!" was the only remark made as the horsemen rode past.

During the formation of a deep cutting on the Great Western Railway, some disagreement arose between the employers and the men, as to the time which should be allowed for rest in the afternoon, it being contended by the former that the days had so greatly diminished in length that the usual half hour ought to be withdrawn. A few men were engaged in the gullet, clearing away the earth in front of the wagons; and the engineer, happening in his superintendence of the work to come near to the top of the hole, heard one of the men exclaim in an angry determined tone:—

"*I* say, as the first man as gives in ought to have his brains blowed out."

"Hallo, Jack," said a voice from above.

"Ay," replied the man in the depths, "who 's there?"

"Mr. S." was the answer, "and I have to say, that as *you* will be the first cur to give in, I 'll lend you a nice brace of pistols which I 've got at home, if you 'll only promise to blow your brains out."

"What, did you hear that, master?" returned the man, with the tone and manner of one "caught in the act." And no more was heard of either pistols or brains. Sometimes a little force, judiciously applied, was necessary, when some drunken fellows took liberties with their betters. Thus, in one case, a "half-seas-over" navvy strolled up to the office of an engineering friend of the writer, and, leaning his head and shoulders against the door-post, made some free and easy remark to "the resident."

"Be off," was the reply. "We don't want any drunken boobies here;" and as he did not seem inclined to move, an order was given to one of the men in the office, who acted as a sort of "man Friday" in that outlandish region, to "bring a bucket of water and fling over that fellow."

Bill started off on his commission, but was rather long in its execution, — a result which was not surprising; for after he had drawn the water, he set it down in one of the back offices, being afraid to bring it forward. Another expedient had to be resorted to; and the resident accordingly walked to the threshold where the man was standing, and laying hold of the door, exclaimed, "We 've no ceremony here," and banged the door to without further delay. Fortunately the navvy had wit enough to make a rapid retreat with his head, or it would have come into unpleasant proximity with the edge of the door and of the post. He then strolled away, for he found he had met with one who was not to be trifled with.

Among those of the navvies who have worked together for any length of time, there is much of blunt, good-natured brotherhood. It may be called a coarse kind of fine feeling. Accidents occurring to their companions sometimes produce strong manifestations of sympathy. On one occasion, an engineer was standing near the edge of a deep gravel cutting, on the side of which some men were working, and pushing the earth down towards the wagons which stood at the bottom. Suddenly a great mass of soil gave way at the top of the cutting, beginning within a few inches of the feet of the engineer, who escaped; but one man was crushed beneath the weight, another was flung into one of the trucks, and a third was hurled completely over them with great violence, but escaped without material injury. So heavy was the mass of earth by which the first

was killed, that a case-knife which he had in his pocket was snapped in two across the blade, though it did not even graze the skin of its unfortunate possessor. This accident occurred in a bright and beautiful summer evening, and the men might, and would, under ordinary circumstances, have worked several hours longer, but so strong was their sympathy with their late companion that they refused to do so; the night fires which had been kindled were extinguished, and they all went away with sad and heavy hearts to their habitations.

That the men not only know how to appreciate a competent and kind master, but that they cherish a grateful feeling towards him, may be illustrated by the fact, that when, during the formation of the Great Western Railway, a number of navvies broke open a Roman urn which they had found, one of them seized with his huge grip a handful of some sixty silver coins, for which the men were scrambling, saying, "These are for Mr. S.,"—the engineer of that part of the line,—and they were duly handed over to him at the first opportunity.

From the sub-letting which is commonly practised in the formation of railways, the chief contractors have little or nothing to do with the men who really perform the work; and hence those who are in fact the railway makers are frequently at the mercy of persons very little removed above themselves in station, and who, from their very obscurity, are to a great extent irresponsible. The consequence is, that of the millions sterling which have been paid as wages to the workmen, a large proportion has been received under very disadvantageous circumstances. It has long been said of sailors, that they often work for their money like horses and spend it like asses, and the remark is in many cases equally applicable to railway labourers. Of those who are employed, joiners usually receive about five shillings; masons, six; and miners from four to five shillings for every ten hours' work, and this looks like high wages. But in many cases great encouragement has at the same time been held out to drunkenness—a crime productive of every domestic and social evil. The money has frequently been paid once only in nine weeks, the settlement taking place at a beer-selling hovel. In the long interval during which the labourer had to wait for his money, he was reduced to the necessity of taking goods on credit at certain houses called "tally-shops," with which the sub-contractors were often connected, or to accept tickets which could be exchanged for goods at these establishments; while the exorbitant profits gained by the sellers when thus trading can readily be imagined. Often, too, the labourer was compelled, by his gang, or

fellow-workmen, to subscribe a gallon of beer daily, and not unfrequently an extra quantity, on some pretext from which he could not escape, if he desired to retain the good opinion of those with whom he worked.

The practice of paying wages on the truck system is illegal, but it appears that in several cases it was almost impossible to prevent it. "The labourer," said Mr. Chadwick, "who might find employment, has found that he can only get it on the recommendation of the beer-shop keeper, or the tally-shop keeper; the labourer has also found that, somehow or another, he could not retain his employment unless he took a certain quantity of beer from the beer-shop, or of goods from the tally-shop;" and the inducement under such circumstances was overwhelming.

The mode of paying railway labourers on some Irish lines has been worse even than in England. On the Mullingar line it was the practice to pay wages by monthly bills, which were liable to discount before the money could be procured. Many of these were for sums as low as one shilling, and were made payable from twenty to thirty days after date at an office in Dublin.

Mr. Chadwick stated that the contracts for the execution of railway works were often undertaken at prices which the engineer, if he was a competent man, knew could not pay the contractors. "I have been informed," said he, "of one piece of work undertaken by a few contractors, who will lose by the work itself, but who will make upwards of £7000 by the truck of beer and inferior provisions to the workmen. Here the interests of the contractors in the sale of beer were greater than in the good execution of the work, and men under their arrangements were often at work in a state of intoxication."

The roving habits of life of the navvies, and their utter disregard of anything like domestic comfort, fostered every species of depravity during the period of railway construction. Mr. Robertson stated, that in June, 1845, he was a witness of the condition of the men on the Sheffield, Ashton-under-Line, and Manchester Railway. During the formation of a large tunnel, there was no town or village in which the labourers could reside, and rude hovels were erected for their "accommodation" near the mouths of the shafts which penetrated the surface of the bleak moor, and at the two ends of the works. The huts were mostly composed of stones without mortar, the roof being of thatch or flags, and built by a workman who lodged a number of other labourers. In some instances, it is affirmed that as many as fourteen or fifteen men existed in one hut containing only two apartments. Some of these were whitewashed and cleanly,

but others were filthy hovels; and from ten to fifteen hundred men were thus crowded together, during a period of six years.

The moral condition of great numbers of these men has been exceedingly low. In many parts where their labours were required, they conducted themselves in the most reckless and disreputable manner, their pay-day being frequently devoted to drunkenness and rioting. On one occasion, a conflict took place at Gorebridge, near Dalkeith, in which a policeman was killed by some Irish labourers. By way of retaliation, a body of about a thousand Scotchmen and Englishmen assembled, and, after driving the "islanders" from the line, proceeded to burn down their turf and wooden huts, the tumult being only quelled by the interference of a large body of police, aided by some dragoons. When the pay-days of the English and Irish labourers engaged on the Lancaster and Carlisle line took place, it was several times found necessary to keep a regiment of infantry and a troop of yeomanry cavalry in readiness to act at the shortest notice; and their presence alone prevented the occurrence of dangerous, and perhaps fatal riots.

As railway works approach completion, and it is difficult to obtain employment, the labourers have frequently undergone the severest privations, having had sometimes to subsist for a week on the wages of a day; while in their migrations in pursuit of employment, they have had to seek shelter in considerable numbers in the union workhouses on their route.

It is gratifying to find, that amidst the depravity so common among such large masses of men, there have been many exceptions; and that a propriety of demeanour has been often shown, which would scarcely have been anticipated. Thus, in a report made to the magistrates of Bangor by the police authorities, it was stated that, eight or ten collegians, who for some weeks had been residing in the town, had been more riotous and disorderly, and had occasioned more trouble to the police, and more annoyance to the respectable inhabitants, than all the six or seven hundred labourers employed within Bangor parish on the Chester and Holyhead Railroad.

On the other hand, however, a frightful picture must be sketched of the condition of large numbers of the navvies, during the period of the construction of so many lines. Living together in some places like herds of brutes—working on the sacred hours of the Sabbath—destitute of instruction, either for themselves or their wretched offspring—subject at every hour of the day to frightful accidents—disregarded by others, and careless for themselves; the last relic of civilization seemed to disappear, as they even changed

their names into the uncouth and barbarous epithets by which they preferred to be known. Painful is it to find that the triumphs which the human intellect has achieved should be so intimately associated with the moral degradation of so large a section of the community.

The means of diminishing these evils are, to a considerable extent, within reach. Great numbers of railway men have returned to their ordinary and regular sources of labour. Where they are employed, they ought to be paid with regularity, and at proper intervals and places: the payments should be made in cash, and never at public-houses. Moveable habitations of wood should be provided for labourers; moral and religious instruction should be placed within their reach by those who have attracted them from the means which they have generally possessed; and the entire arrangements should be subject to proper supervision. Public works do not necessarily engender moral depravity: and if a wise and systematic course of procedure were adopted, a vast aggregate of sin and misery would be prevented.

Before leaving this subject, it would be unjust to pass unnoticed the efforts which have been made by some contractors and Companies for the promotion of the social, moral, and religious welfare of the men whom they have employed. Among these, the name of Samuel Morton Peto stands forth in distinguished prominence. He was the eldest son of Mr. William Peto, of Cookham, Berks; he was born at Woking, in Surrey, in August, 1809. Apprenticed at an early age to the business in which he has been engaged, he soon attained a practical knowledge of its details. Even before the attainment of his majority, the singular aptitude of his talents so matured the fruits of his seven years' experience under the tuition of his uncle, to whom he had been bound, that on the death of that gentleman, in 1830, he found himself the successor to a moiety of one of the largest builders' establishments in the country, his joint partner being Mr. Thomas Grissell, another nephew of the deceased. Mr. Peto also came into possession of a very large fortune by his uncle's will. "The seemingly precocious ripening of Mr. Peto's judgment will appear to be less inexplicable, when it is stated, that in pursuing the study of his business, he did not confine himself to a mere acquaintance with its theory, but gave a laborious and zealous devotion to the manual pursuit of the three several handicrafts chiefly required in such establishments. He worked—and those who know his character can judge of the energy he imparted to his labours—not as the relative and future heir of one of the leading

contractors of the kingdom, but as if he were destined, during his whole life-time, to earn his livelihood as a journeyman, in the capacity of a carpenter, a bricklayer, and a mason; and there cannot be a question, that, besides the inestimable utility he derived from the insight thus voluntarily acquired, into the mechanism of labour, so essential to his calculations in its employment in vast organized masses, he also thus became familiarized with what may be called the idiosyncracy of the English mechanic, and he has, consequently, been enabled to convert such knowledge to the accomplishment of the moral results observable on his works."*

* Illustrated London News, No. 469.

CHESTERFORD STATION—EASTERN COUNTIES RAILWAY.

CHAPTER VII.

Tunnels—When Tunnels are required—Shape of Tunnels—Stipulations with the Contractors—Process of the Formation of a Tunnel—The Horse-gin—Shafts and Drift-ways—Brickwork Lining of Tunnels—Timbering—"Fitting the Joints"—Testing the Levels and Range—Extraordinary Correctness of Tunnel-work—Illustrations—Air-shafts—Appearance of a Tunnel Shaft from below—Kilsby Tunnel Shaft—Shaft Towers—Horizontal Galleries—Shakspeare's Tunnel—Open Tunnels—Cost of Tunneling—Tunneling in Rock, Clay, and Chalk—A Strange Accident—Slips in Tunnels—"Tapping" a River—Drainage of Tunnels—Self-supporting Tunnels—Visit to a Tunnel in course of Construction—Strange and Novel Spectacle—Instance of Marital Docility—Question of the Unhealthiness of Tunnels examined—Primrose-hill Tunnel—Telegraphs for Tunnels—Proposal for a Tunnel under the Severn at Hock Crib—Wadhurst Tunnel—Box Tunnel—Kilsby Tunnel—Sheffield and Manchester Railway Summits Tunnel—Entrances of Tunnels—Shugborough Tunnel—Slopes of Tunnels—Dimensions of Tunnels.

IN the construction of a railway of considerable length, it is usually found that some portion of the earth rises to such a height that it is best to conduct the line underground, by means of a tunnel. It is a rule which may be regarded as generally applicable, that to make a cutting more than sixty feet deep, would be costlier than to "bore," unless the material is required for a neighbouring embankment. Economy is the principal test in these matters; for, in the present advanced state of engineering, a tunnel may be made of almost any length, and through almost any substances, from granite rock to quicksand; and, therefore, the nature of the ground can hardly be said to oppose any other obstacle than that occasioned by the cost.

One of the most important considerations in the formation of a tunnel, is the shape of which it is to be constructed. The decision of this point materially depends on the nature of the ground, and the weight which the brickwork will have to support. Thus, in a wet quicksand, which approaches to the nature of a fluid, the form will approximate as nearly as possible to that of a circle; and for other kinds of pressure, it should be proportionately modified.

All the works of a railway are performed, as we have already seen, by contract; and the nature of the agreement entered into between the Directors and contractors, especially in undertakings of this kind, is a matter of great importance. To some of the more important points we may allude.

In the agreement made with the contractor for the formation of the tunnel, the price of the work, and a schedule, by which any extra or additional works are to be executed, is given; and the mode of payment, and the nature of any retentions, if such there should be, is also specified. In the best-managed contracts, the time for completion, and the fines for exceeding this period, are stated; with the condition that all payments are subject to the engineer's approval of the work. The contractor finds tools, labour, and materials, gets out all foundations, excavations, shafts, culverts, drains, roads, etc., and provides centreings, pumping apparatus, scaffolding, fencing, and other requisite materials of every description, according to the specifications, plans, and drawings, and the instructions which he may from time to time receive from the engineer. He lays the permanent way, the materials of which are found for him by the Company. When he does not employ a sufficient number of men on the work, the engineer should have the power to engage more, after giving him a week's notice to that effect. These may be retained temporarily or permanently, as may be required, and in all cases using the contractor's materials, the pay of the men being deducted from the price of his contract. It is also considered that the engineer should have the power of discharging any foreman or workman acting improperly, or doing his work carelessly. The ground over the tunnel should be fenced off previously to commencing the work. The contractor should be restricted from entering on any adjoining land without leave: and if this should be necessary, after the leave is obtained, it should be immediately fenced off. Temporary roads for the conveyance of materials from the high roads, when required, should be formed by the contractor; as also those necessary for conveying away the spoil-earth.

The contractor should further be bound to alter or take down any work not approved by the engineer. All materials, from the moment they are brought upon the site of the works, become the property of the persons for whom the tunnel is made, and the contractor must not remove them again without permission; but the Company making the tunnel is not answerable for the damages which any materials may sustain. These and similar clauses in the agreement are, of course, only provided in cases of special emergency,

and would seldom require to be acted on. The contractor should be furnished with copies of plans, sections, and other drawings, and also of the specification, the correctness of which he must ascertain for himself; he is also to do all that may be reasonably implied, if not actually expressed, in the drawings and specification. It is usual to deduct ten per cent. from the payments; the whole of which is not returned to the contractor till twelve months after the completion of the work,—he being bound to keep it in repair for that length of time. The payments are in general made monthly, including those for extra and additional works, after being approved by the engineer. It is also usual, in large works of this kind, when the contractor has more than two millions of bricks on the site of the work, to allow him half or two-thirds of their cost. When the work of tunneling is about to be commenced, the cuttings which approach the opposite ends are carried up to the points where the boring is to begin; the face is then scraped, and the men are set to work at the tunnel. In the excavation of short works of this kind, they are done from the ends only, but when they are of considerable length, vertical shafts are sunk from the summit of the hill above,

THE HORSE-GIN.

to the required level. This operation is usually begun by the aid of the horse-gin, which informs the engineer or the contractor of the

nature of the strata through which he has to pass, and which is very useful in indicating the peculiarities of the soil to be worked.

When the shaft is finished, the men can descend it, and prepare other portions of the tunnel; and thus, in fact, several short tunnels are made, which are ultimately united. In this way a great number of men may be employed on the undertaking at the same time, without confusion, and the whole may be completed within a comparatively short space of time.

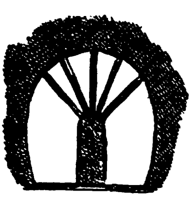
The shafts are usually about nine feet in diameter, including the lining of brick-work laid in cement, nine inches in thickness; the bricks are laid with their ends towards the shaft. The width of the shaft, however, depends materially on the circumstances of the particular case: some being only three or four feet, while most of those of the Box tunnel are as much as twenty-five. The brick-work protection to the sides is executed in sections as the workmen gradually proceed lower, and when the shaft is carried to its full depth, the lining, as it is termed, is completed. The miners then commence the lateral excavations, by forming a drift-way along the level of the upper part of the tunnel, and this is sometimes continued throughout the whole length, and affords a satisfactory test of the nature of the work, the position of the strata, and the obstacles to be overcome in its completion. This is occasionally done before letting the contract for the tunneling.

The manner in which the brick-work is laid is of great importance, of which an illustration will be subsequently given. In a quicksand it has been found necessary to lay the lining to the thickness of twenty-seven inches in the sides and top, and eighteen inches in the invert, Roman cement being also used. This, however, is the greatest strength ever required; and, as the nature of the ground will allow of it, this may be lessened till the point where the material will stand by itself has been reached. Each brick should be well bedded with a wooden mallet; and, when the shaft of the tunnel requires it, the bricks must be moulded of a taper form. In the arch they are laid in concentric rings, half a brick thick, taking care that the additional number of bricks requisite for each additional ring is inserted.

During the whole of these processes, the bricklayers should be well watched, to see that they do their work in a thoroughly satisfactory manner; for upon this the future stability of the tunnel depends. This is as important in reference to the invert as to the arch, for as much depends on the strength of the one as on that of the other, while too frequently this is regarded by the workmen as of minor importance; and as it is more out of sight when completed

than other portions of the work, it has a corresponding chance of being slurred over. In many cases the low price that the men are paid for task-work, leads to their hurrying it, to make up their wages; and in other cases, where they are well paid, unless they are carefully watched, the opportunity of making greater gains is an inducement to slight the work. The system of sub-letting, and then again sub-letting in detail, has invariably an injurious effect upon the soundness of the work.

Where the circumstances are such that the ground will stand with little or no timbering—as is, to a great extent, the case with rock and chalk—the operation of tunneling is of the simplest character. The only thing against which it is especially necessary to guard, is the first displacement of the strata; and this can generally be prevented with only slight timbering, judiciously placed. But if this be not watched and provided against in time, a slip of rock will frequently bring in as much as to leave a great cavern, which must be filled up solidly behind the work, to make it secure from future danger. The diagram shows the manner in which timbering is arranged in the construction of tunnels of this kind; and it is similar to that adopted in the formation of the Abbot's-cliff Tunnel, which was made through the lower chalk between Folkestone and Dover. The sides are first excavated, leaving a pillar in the middle, which serves as a prop, on which to support the roof, and also to sustain the centres for turning the arch.



When the side walls are up, the pillar may be removed; but this mode of proceeding is not so advantageous when an invert has to be inserted, as great care is required in propping the arch during the construction of the invert and the side-walls, for the "under-pinning" of the arch; because the central pillar, which was left to carry the props and centres, must be removed before the invert can be commenced, and that must be completed before the side-walls can be erected. This method has been practised, to a limited extent, by constructing the arch first, then excavating the lower parts, and, by constructing the invert and side-walls, under-pinning the arch. Thus it will be seen that such a procedure is better suited for rock and chalk tunnels, where no invert is required, than for heavy ground, where one is indispensable, and where considerable risk would attend the operation. It was, however, successfully accomplished in a large part of the Martello Tunnel, near Folkestone, on the South-Eastern Railway, through the junction of the chalk, upper green sand, and

gault, the latter stratum being found in the lower part of a portion of the tunnel.

The arrangements that are made by which the several portions o a tunnel shall at last meet together, are such, that the result is usually attained with surprising accuracy. This was tested on the Leicester and Swannington Railway in the following manner: Prior to the visit of the Directors on the completion of the work, twenty-five candles were fixed at intervals along one of the sides of the tunnel, at a distance of two inches and a half from the wall; on their being lighted, it was found that their relative position did not vary a quarter of an inch from the required line. In the Bletchingly tunnel also, which had eight shafts, it varied but a single inch from a perfectly straight line. In a length of more than fifteen hundred feet between two shafts of the Box tunnel, which has an incline of one in a hundred, the junction of the two workings was perfectly effected as regards the level, and did not deviate more than an inch and a quarter at the sides. The drift-ways of the principal tunnel of the Sheffield and Manchester Railway, which penetrates for three miles through rock formation, and is at one part more than six hundred feet below the surface of the hill, were also effected with great exactness. Five shafts were opened, from which the work was carried on; and while these were in progress, drift-ways were made from each face of the mountain, extending to nearly a thousand yards at the eastern side, and one hundred and eighty yards from the next shaft. When these were completed, the levels were tested, and found to have varied less than an inch, and the range was within two inches of being geometrically true. Though the difficulty is greatly augmented in the formation of curved tunnels, yet extraordinary accuracy is attained; and thus in those on the Glasgow and Greenock Railway at Bishopton, the deviation nowhere exceeded two inches.

In order to prevent the accumulation of foul air in the workings of tunnels, and to assist in dispelling the otherwise impenetrable gloom, small air or light shafts of three or four feet in diameter are also sunk by the contractors. They are formed in a similar manner to the working shafts, the masonry at the lower ends resting on a cast-iron ring imbedded in the roof of the tunnel, and they are built, at the upper ends, about ten feet above the surface, and coped with stone.

In the Kilsby tunnel, which is more than a mile and a third in length, there are two air-shafts. Their appearance is very curious, from whatever point of view they may be regarded. The visitor has

perhaps walked from one end of the tunnel to the shaft, and when he reaches it, he hears a deep thunder muttering in the distance, and some advancing body is seen to darken the little horizon of the tunnel mouth, while the bright gleam of fire, and the more distinct sound of the approaching body, tells that it is a train. On it comes,—the hollow walls flinging forward the sound, and condensing it into harsh murmur. He stands back in the recess of the shaft, where he can see the thundering mass as it approaches; and emerging for a moment in the daylight of that spot, it quickly disappears in the gloom of the opposite direction, with its red tail-lamp burning a sickly defiance to all behind. The scene thus presented has been portrayed by the pencil of our artist.

SHAFT OF KILSBY TUNNEL.

If the visitor looks up, a novel spectacle is witnessed. The long shaft towers far aloft, its dark sides sweating with the moisture of the earth which has forced its way between the bricks; while far up the fleecy clouds pass over the face of the sky, or, intervening between the observer and the sun, send their long shadows into the "hollow cavern" where he stands. These shafts seem as oäses of light in the long and dreary pilgrimage of that dark tunnel. When

a tunnel has been completed, it is usual for several of the shafts to be closed, a few being sufficient for the purposes of ventilation. At Bletchingly tunnel all but one were left open, and at Saltwood five were preserved for the same purpose; the others were shut by closing them just above the arch of the tunnel, and filling up with earth to the surface. For the prevention of accidents, the brick-work of the shafts is usually carried up to some height above the level of the ground, in the form of a tower, and then covered with a flat or domed iron grating, in order to prevent stones falling through, should they be thrown by mischievous or malicious persons. The towers are sometimes situated on the summit of the spoil-bank, and are a continuation of the brick-work of the shaft.

In the formation of a tunnel through the side of a hill, considerable expense has sometimes been saved by the construction of horizontal galleries from the face of the hill to the side of the tunnel, and by removing the excavated earth through them. The double tunnel through Shakespeare's Cliff, near Dover, on the South Eastern Railway, was constructed in this manner. Seven vertical shafts from the top of the hill were first sunk, and seven horizontal galleries were then made from the face of the cliff which united with "the verticals;" and the two tunnels were then excavated parallel to the sea, from which they run at a distance of four or five hundred feet. A road was previously formed along the front of the cliff to afford means of access for the workmen. The galleries were each about six feet wide, and seven high; and the excavated chalk was conveyed along them in small tram-wagons, and tipped into the ocean below. During the construction of the tunnel, the company courteously permitted the public to visit the scene of operations, and the spectacle was unique and impressive. On entering the bore, a lantern was furnished to the visitor, who was allowed to venture as far within as his courage, or his lack of it, directed. A slight glimmering of daylight tempted some onwards, but it was insufficient to dispel the darkness which seemed but to be rendered "more visible" by the lantern. On reaching the first shaft daylight was again enjoyed, while the aperture overhead extended to a height nearly equal to that of the Monument of London; seven times did this recurrence of the sun's beams break on the gloom of the long cavern; while those whose perseverance and energy were not exhausted, might witness the extensive preparations at the other end, then making, for continuing the line along the base of the cliffs near the sea-shore of Folkestone.

It is here worthy of remark that all tunnels are not bored. Some

are constructed by first making a cutting, and having this afterwards arched over and filled in; these are denominated *open tunnels*, and the one at Kensal Green furnishes an illustration in point. They are sometimes preferred where it is desired to avoid the permanent severance of valuable lands; and, when formed, the sides of the cutting are made nearly vertical, and are supported by timber framing till the brick-work is finished.

The cost of tunnel making varies greatly. It is estimated that those formed for the old canals were less than £4 per lineal yard; and that for railways of the ordinary dimensions, they vary from £20 per yard in sandstone rock—which is easy to excavate, and does not require a lining of brick-work—up to £100 and £160 per yard in very loose ground, such as a quicksand, which may render it necessary to have brick-work lining of great thickness.* The Kilsby tunnel cost about £125 per yard. If they are freely worked, rocky strata are usually the cheapest for tunneling, from the opportunity that is afforded of using gunpowder, and the absence of masonry. In the blastings for this purpose at Bishopton, on the Glasgow, Paisley, and Greenock Railway, 314 tons of gunpowder were employed in a length of 2300 yards in hard whinstone, some veins of which were so difficult to work, that the rate of progress at each face of the excavation varied from three feet six inches to six inches only a day.

Tunneling in clay is often very expensive and difficult. When tough it is difficult to work; blasting is of no avail, and spades and pickaxes are almost useless. Lecount states that, under such circumstances, hatchets may be employed to advantage, but that cross-cut saws best answer the purpose. The difficulties which the working of this material presents were illustrated in the case of the Primrose-hill tunnel, which passes through the London clay. To provide against obstacles which might arise, the engineers adopted the precaution of excavating only nine feet in advance of the brick-work, and supporting the clay by very strong timbering, till the arching was completed. The great mobility of the moist clay, however, made it exert so extraordinary a pressure on the brick-work, as to squeeze the mortar from the joints, and to bring the inner edges of the bricks in contact. The result was, that the bricks were, by degrees, grinding to dust, and the dimensions of the tunnel insensibly, but irresistibly, contracting. The only means by which the evil could be counteracted was the use of very hard bricks laid in Roman cement, which, by setting before the pressure became so great as to force them into

* The celebrated Thames Tunnel cost about £1200 per yard!

actual contact, enabled the whole surface to resist the pressure. The thickness of the brick-work was augmented almost throughout to twenty-seven inches.

Great danger arises in the making of tunnels from slips; and thus, in the construction of the Fareham tunnel on the Gosport branch, a fall of the superincumbent earth carried away about forty yards in length of the brick arching, though it was of the extraordinary thickness of three feet. In tunnels bored through chalk, it is often necessary to act with great caution, as it sometimes contains large holes filled with gravel, which, on being opened during the execution of the work, pours in on the unsuspecting miner like water. Thus in the Watford tunnel, which passes through the upper chalk formation, where it is covered with a thick irregular bed of gravel, such breakings-in occasioned great inconvenience and delay. The chalk had fissures, sometimes a hundred feet in depth, filled with gravel, which when worked into, "rushed down with such violence, as to plough the sides of the tunnel as if bullets had been shot against it." Such an accident, occurring at the foot of one of the working shafts, overwhelmed ten men who were there at work, and led to the construction of the large ventilating shaft near the centre of the tunnel, which occupies the side of the cavity. Loose sand is, perhaps, the most difficult material that can be encountered in tunneling, but, in several instances, it has been successfully traversed.

In the making of tunnels it is important that the drainage should be complete. A drain with the joints slightly open, so as to admit the water from the ballasting, should be laid along the centre of the road, and the water that percolates through the brick-work should be conducted down the inside of the arch by similar means. Great difficulty has been experienced in the prevention of injury to the masonry of tunnels by the inroads of water, and various contrivances have been adopted to obviate the evil. At the Cheviot tunnel near Wakefield, it has been prevented by lining the roof with sheet lead; and in the Beechwood tunnel of the London and Birmingham line, by an interior lining of brick-work nine inches thick, behind which a system of drainage is arranged.

From the firmness and stability of the native material, brick-work linings to tunnels have in some cases been dispensed with. This is the case with the Penmaenbach tunnel on the Chester and Holyhead line. The excavation is through basaltic rock, and has upright sides and a semicircular top. The Bangor tunnel was also at first considered to be sufficiently solid, but having subsequently evinced

symptoms of inability to withstand the influence of the weather, Mr. Stephenson ordered it to be lined with brick. So matured has been the experience of engineers in the work of tunnel making, that though, in the formation of the Caledonian Railway, the tunnel under the hill to the north of Glasgow had to be conducted *over* the Edinburgh and Glasgow Railway and *under* the Monkland canal, and within a few feet of both, yet the work was successfully completed.

In order to gain an adequate idea of the peculiarities of tunnel excavating, the scene of operations should be visited; and it will then be found that transactions are going on below the surface of the earth full of striking interest. On approaching one of the shafts there will probably be seen the ponderous engine and pumping-gear, and an immense mound of rock or earth-spoil, the produce of the tunneling below. Here are also temporary offices and buildings for the use of the contractors and their men, and other indications of the magnitude of the undertaking. Permission having been duly obtained of the authorities, and the assistance of a guide secured, the visitor will then take a slender candle stuck in a lump of clay, and prepare himself for his subterranean exploring. Having deposited himself in a tub, and overcome the slight giddiness which the descent may induce, he will observe the lining of the shaft, and the straining of the pumps essaying to lift the mighty volume of water which is continually supplied from the streams which issue in all directions from the crevices and fissures of the earth or rock. These create a sort of Scotch mist, sufficient to wet a "Southern man" to the skin; but, what is remarkable, it does not extinguish the fragile candles, which burn with singular brilliancy. Having descended to the level of the tunnel itself, this may be explored in either direction. And now a striking scene fills the beholder with mingled wonder and awe. A great number of men are at work at either end of the tunnel, some having penetrated into a drift-way perhaps thirty feet beyond, while the light which flickers from innumerable "dips," stuck around in all directions, gives a strange appearance here to every object. Some of the men are picking the earth from the sides, others collecting it, by means of shovels and barrows, in a heap out of the way of the miners; while the explosion of gunpowder which has been let into the rock, the crash of the solid material which has been riven in pieces, the fall of the rude masses, and the reverberation sounding through the gloomy caverns, are sufficient to fill the stoutest hearts of those unused to such scenes with alarm, and to leave an impression not easily effaced.

Nor should the undertaking be recommended to those who are not prepared to encounter such risks, and who have not a strong inclination for the adventurous.

On one occasion some of the Directors of the Great Western Railway were inspecting the works at the Box tunnel, and several of them resolved to descend a shaft with Mr. Brunel and one or two other engineers. They accordingly ensconced themselves in a tub provided for that purpose, but one of the party declined to accompany them. His friends rallied him about his want of courage, and one slyly suggested—"Did your wife forbid you before you started?" And when a quiet nod in response intimated that the right nail had been struck, the discovery was received with a merry laugh. But as the pilgrims found themselves slipping about a greasy, muddy tub, jolting and shaking as the horses stopped—by whose aid they were lowered,—and that at length they were suspended some hundred and fifty feet from the bottom, till the blastings which had been prepared roared and reverberated through the "long-drawn caverns," more than one of the party who had laughed before, now wished that they had received a similar prohibition to their friend above, and had manifested an equal amount of marital docility.

Much having on various occasions been said of the unhealthiness of tunnels, a few remarks may not here be inappropriate, for the benefit of those who may yet feel any timidity on the subject. Before the opening of the London and Birmingham line, it was resolved that the matter should receive a thorough investigation; and this was accordingly intrusted to Dr. Paris and Dr. Watson, Messrs. Lawrence and Lucas, surgeons, and Mr. Phillips, Lecturer on Chemistry, who made their observations on the Primrose-hill tunnel. They reported that the air for many feet above their heads was dry, clear, of an agreeable temperature, and free from unpleasant smells, and that the sensation experienced, as they passed along in a train, was precisely that of travelling in a coach by night between the walls of a narrow street. "Judging from this experiment," they said, "and knowing the ease and certainty with which thorough ventilation may be effected, we are decidedly of opinion that the dangers incurred in passing through well-constructed tunnels, are no greater than those incurred in ordinary travelling upon an open railway, or upon a turnpike road; and that the apprehensions which some have expressed, that such tunnels are likely to prove detrimental to the health, or inconvenient to the feelings, of those who go through them, are perfectly futile and groundless." The Kilsby tunnel is also "traversed without the slightest inconvenience or sensation of cold or

damp, the change experienced being merely that from sunshine to shade, and from daylight to lamplight."

The existence of a tunnel on a railway renders it necessary that various arrangements should be made, especially if it be in the neighbourhood of a station, to forewarn the officials of the approach of the various trains. As these are of a very similar nature, a description of one of them will suffice. The Primrose-hill tunnel is situated about a quarter of a mile from the Camden station. By the side of the southern entrance—which is faced with the finest Portland stone, and cost £7000—is the lodge of a policeman, who holds constant communication with another of his fraternity at the opposite end, by means of an electric telegraph, and from whom he hears of the arrival of trains from the north, intelligence of which he communicates to the people at the Camden dépôt. The face of the telegraph has on it the words—"train in," "train out," "line clear," "line blocked," any of which communications either policeman can make to the other; thus perfect order and regularity are observed. Fastened againat the framework of the tunnel, at the southern end, is a large bell, and also a reserve one in case of accident. As soon as the bell of the telegraph at this end rings, the policeman knows that a communication is about to be made from the opposite end, and on looking at the dial, he finds that there is a "train in" the tunnel. Acknowledging the information, he proceeds to the bell, and pulling a rope attached to it, which acts in a similar manner to the drawing up of a clock, it is set "a-ringing," and thus due notice is given to another policeman at Camden, who, by means of a bell with which he is provided, repeats the signal, so that it can be heard all over the station. Meanwhile, the tunnel policeman turns on a signal either of "all right," "caution," or "danger," according to the circumstances of the case, and which is obeyed by the driver of the engine as he emerges. If the last signal is given, the steam is instantly shut off, and the train brought to a stand-still before it reaches the station; the second is the one usually given to signify that the driver may proceed at a moderate speed across the station till he reaches the ticket-platform, where arrangements have in the interim been made to receive the tickets of the passengers. Similar arrangements are now made for all tunnels of any considerable length.

As a fact strikingly illustrative of the enterprising spirit of the present day, which no natural difficulties seem to daunt, it may be mentioned, that the South Wales Railway Company deposited plans for what was termed an "alternative line," in which it was proposed

to construct a tunnel under the Severn, if permission were refused for erecting a viaduct over it. The tunnel was to have been made at Hock Crib, where the river is nearly half a mile in width; but as it must have been begun a considerable distance from the shore, on each side, it must have been a mile and a half long, besides cuttings of nearly another mile. The depth of the foundation of the tunnel appeared on the plans to be about twenty-six feet, with an inclination of one in a hundred. But the Admiralty surveyors gave sixty feet as the proper depth of any tunnel; but to comply with this requirement, it would be necessary either to increase the length of the tunnel to double its proposed extent, or to have had such an inclination as it would have been very difficult for locomotives to overcome. Another point also deserves remark, as showing one of the manifold obstacles which are found in connexion with such undertakings—the crown of the tunnel would have been but six feet below the bed of the river, which would have been an insuperable impediment in the way of any improvement in the navigation at that point, at least by any process of which dredging would form part. By practical men of eminence, however, it was from the first considered that the monstrous expense, the immense difficulty of the construction, and the almost interminable period which would have been occupied in a work of such magnitude, would prove an effectual bar against its being undertaken.

The Box tunnel, between Chippenham and Bath, is one of the most remarkable railway works that has been completed. It is nearly 9400 feet in length, and part of it is 400 feet below the surface of the hill through which it passes. Thirteen shafts were required in its construction and ventilation; the material excavated amounted to 414,000 cubic yards, and the brick-work and masonry was more than 54,000 yards. The number of bricks used was 30,000,000; a ton of gunpowder and a ton of candles were every week for two years and a half consumed in blasting and lighting, and 1100 men and 250 horses were constantly engaged. For a considerable distance the tunnel passes through freestone rock, from the fissures of which the water flowed so freely, that in November, 1837, the steam-engine employed for its removal proved insufficient, one division of the tunnel was filled, and it rose fifty-six feet high in the shaft, so that it was found necessary to suspend operations till the following Midsummer, when a second engine of fifty-horse power was brought to the assistance of its brother leviathan, and the water removed. After another irruption which took place, the water was pumped out at the rate of thirty-two thousand hogsheads a day.

The summit tunnel on the Sheffield and Manchester railway, to which reference has already been made, is the longest yet constructed, although, in point of capacity, it is one of the smallest. It is 5300 yards long, or more than three miles. It is situated near the point of junction of Cheshire, Yorkshire, and Derbyshire,—one end near the village of Woodhead, in Cheshire, and the other in Yorkshire, and passing under a bleak hilly moor, chiefly covered with dark heath and bog, barren and dreary in the extreme. The tunnel was formed by means of five vertical shafts sunk from the surface of the moor, averaging about 600 feet in depth. Around these and the two ends were clustered the huts that served as the temporary homes of the workmen, forming a sort of scattered encampment between two and three miles long. The secluded position of the works rendered these erections absolutely necessary. The tunnel was in progress about six years, during which the number of men employed underwent considerable fluctuations; but is said to have been at one time as great as 1500. As the tunnel passes chiefly through rocks of sandstone and millstone grit, the enormous quantity of 3485 barrels, or upwards of 157 tons of gunpowder were employed in blasting; and, owing to the great influx of water, nearly 8,000,000 tuns had to be pumped out during the progress of the work. The greater part of the rock excavated had to be hoisted, from the depth of about 600 feet, by steam-engines, to the surface.

The entrances of tunnels should be various in style, yet consistent with the style of work. They should be massive, to be suitable as approaches to works presenting the appearance of gloom, solidity, and strength. Mr. Simms, the engineer, has well remarked, that a light and highly-decorated structure, however elegant and well-adapted for other purposes, would be very unsuitable in such a situation: it is plainness combined with boldness, and massiveness without heaviness, that in a tunnel-entrance constitutes elegance; and it is at the same time most economical. These conditions may be answered without cramping the taste of the engineer, as far as taste enters into the composition of such designs; for architectural display in such works would be as much misplaced as the massiveness of engineering works would be, if applied to the elegant and tastefully-designed structures of the architect.

The appearance of the mouths of some tunnels, especially when thrown out into prominent relief by a pleasant and well-wooded landscape stretching around and behind them, is by no means unattractive. As a proof of this statement, a better illustration could scarcely be furnished than that of the Shugborough Park tunnel, on

the Trent Valley Railway. The north face of this structure forms a noble archway, deeply moulded, flanked by two square towers, the whole being surmounted by a battlemented parapet. The lofty trees, covered with the richest foliage, rising from the elevated ground

SHUGBOROUGH TUNNEL.

through which the tunnel is pierced, give a depth of tone and artistic effect to the whole scene at once imposing and beautiful, and form a remarkably fine feature in the scenery of the railway.

CHAPTER VIII.

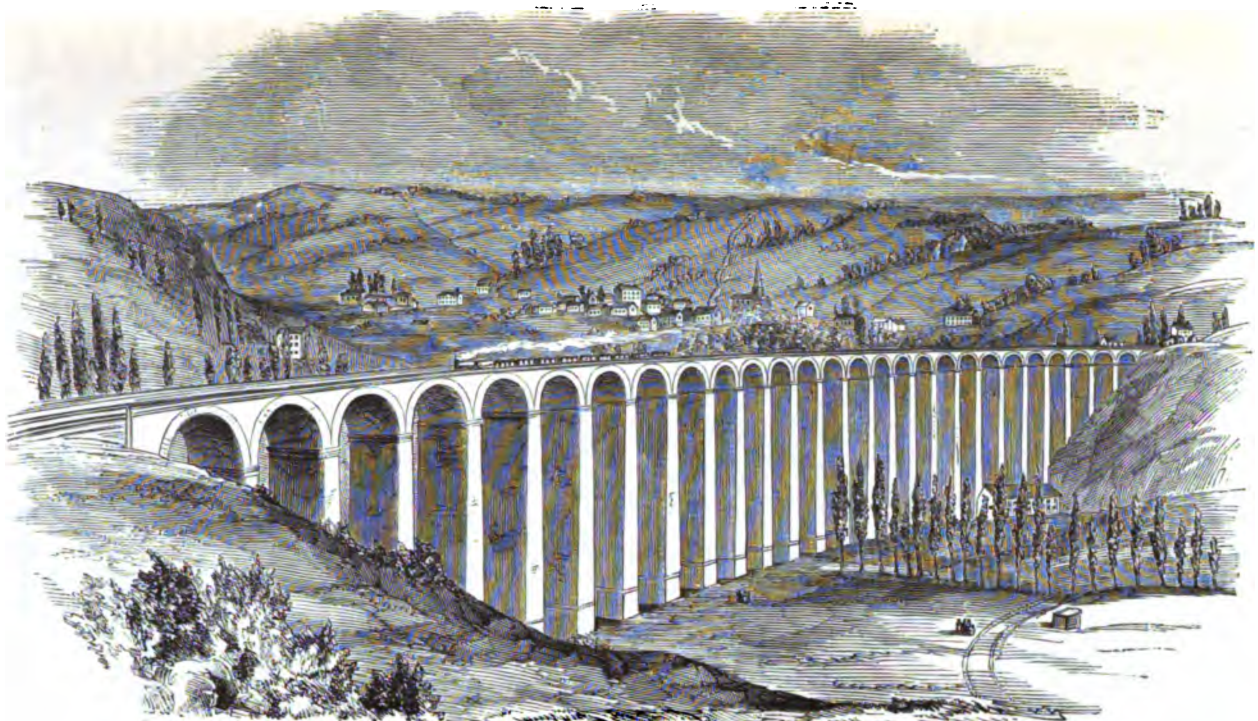
Viaducts—Advantages of Viaducts—Materials employed—Varieties of Construction—Timber Viaducts—Timber and Stone—Green's Laminated Structures—Viaduct at Bezons—Sankey Viaduct—Dane Valley Viaduct—Avon Valley Viaduct, on the Midland Railway—Congleton Viaduct—Dinting Viaduct—Etheron Viaduct—Foord Viaduct—Skew Viaduct over the Ogden Valley—Ouse Viaduct—Dee Viaduct—Drainage of Viaducts—Cost of Brick, Stone, and Timber Viaducts—Bridges—Use of Bridges—Abuse of Bridge-making—Number of Bridges—Foundations of Bridges—Skew Bridges, why constructed and where—Winkwell Skew Bridge—Rugby Road Bridge—Maidenhead Bridge—Arun Telescope Bridge—Floating Bridge on the Forth—Conway Tubular Bridge—Wye Tubular Bridge—Britannia Tubular Bridge—The Project—Position of the Bridge—Plates—Rivets—Scene at the Works—Piers and Abutments—The Floating of the Tubes—Trial of the Tubes—Graphic Sketch by an Observer—Appearance of the Bridge—Dimensions of the Bridge—Successful Issues of great Engineering Undertakings—Exercise of Inventive Power—Modern "Landmarks of Ages."

THE viaduct is an important auxiliary in the construction of railways. The ever-varying circumstances under which it may be rendered available forbid the establishment of specific rules, either as to the occasions of its adoption, or the precise materials of which it should be composed. The question is usually one of economy. On a line approaching a town, it is indispensable that some means should be obtained to prevent interference with the traffic on the numerous streets which it is sure to intersect; and though this is sometimes effected by a tunnel, as at Liverpool, where the line passes under the houses; or by an open cutting traversed by bridges and short tunnels, as is the case near the Euston Station; or by an embankment, as at Manchester, Birmingham, and many other places—yet this is frequently accomplished by means of a viaduct, or by embankments in which short viaducts are formed. The lines from the City to Blackwall, and from London Bridge to Greenwhich, may indeed be styled viaduct lines, and the continuation of the South Western Railway

from Nine Elms to the Waterloo Station, is thus constructed for the entire distance of about two miles. By the adoption of this method a great saving of land is effected, as it is necessary to purchase little more than the actual width of the line, and this is an important item where it is carried through densely peopled districts; while the heavy cost of purchasing and conveying earth to make an embankment is avoided. A smaller annual sum is also required for repairs, and the vacant spaces beneath the arches may be let for tenements, shops, or warehouses, or fitted up as ragged schools, for "nightly homes for the homeless," or other purposes.

Viaducts are of great value in traversing rivers, ravines, or deep valleys, especially where materials for the formation of embankments are scarce; they are chiefly employed in this manner. As an illustration of the contingencies which arise in the construction of engineering works, it may be mentioned that a viaduct having on one occasion been planned across a wide and deep valley on a series of lofty arches, it was found in the course of the execution, that the precise spot on which it was intended to rear one of the central pillars, came exactly over the mouth of an ancient coal pit.

The materials of which viaducts are constructed are various. Stone, brick, iron, and wood have been employed separately and together; while the success which has attended their application, both as respects cost and permanence, has been various in different cases. Where the original outlay is an object of special importance, the erection of timber viaducts has been resorted to, the beams being trussed with iron; and thus the expense of excessive coffer-damming in traversing water has been avoided. One of these structures may be seen on the Derby and Birmingham line, which crosses the Thame and Trent rivers. Its length is more than twelve hundred feet, and its mean height thirty-three feet; but its cost per cubic yard was little less than that of many stone structures. On the North Union line a timber viaduct of great length has been reared; and on some of the Scotch railways the system of trussed-beam viaducts has been applied to very large spans. Another timber viaduct, which combines great lightness of appearance, economy of materials, and smallness of cost, compared with that of an embankment or brick-work arcade, connects the Bricklayer's Arms Station with the main line of the Brighton and the South Eastern Railways. The wood was previously submitted to Payne's anti-dry-rot process, by which it is not only protected from vegetable decomposition, but also from fire, to which it is exposed from the falling of burning coals from passing engines.



THE TARENTIN VIADUCT.

A timber viaduct of similar shape has been constructed to bear the South Eastern Railway between the Shakspeare Tunnel and the Arch Cliff Fort at Dover, the piles being driven into the solid rock. The light open framework supports an elevated platform, on which the rails are laid, while the sea beats on the "unnumbered idle pebbles" that lie below. A sea-wall, it is believed, would have been washed away.

Timber is frequently employed in combination with stone in the formation of viaducts. One of the largest works of this kind is known as Green's laminated bridge, on the Newcastle and North Shields Railway. The piers are of stone, and there are five arches of one hundred and twenty-six feet span, besides two others of smaller dimensions; they are altogether more than a thousand feet in length. Its cost is stated at £24,000; and as it is estimated that £7000 more would have sufficed to have built it entirely of stone, the question of economy will depend on the relative permanence of the materials. There is another stone and timber viaduct on the Paris and Rouen line, at Bezons. The stone piers are raised upon artificial foundations, brought up to the level of the water by means of concrete inclosed within a sheeting of oak piles, driven as closely together as possible, and secured by iron straps and bolts. The bridge consists of ten arches; but in point of economy the structure cannot be regarded as worthy of imitation.

There is another timber and stone viaduct on the East Lancashire line, where it crosses the River Irwell at Alderbottom. It is an elegant structure, consisting of bays or openings, composed of timber framing, resting on stone piers. The bridge carrying the old line of railway is nearly adjoining to this, but at a much less elevation; the new route being selected because of the increased power of locomotives permitting the use of steeper gradients than were at first admissible.

The Sankey Viaduct is also a "composite" building: its ten arches are supported on about two hundred piles, varying from thirty to forty feet in length. It crosses the Sankey valley, at the bottom of which runs a canal; and is made of brick, with stone facings.

The Dryfe Sands Viaduct (see Engraving, next page), on the Caledonian line, is a good illustration of plainness of style combined with strength and beauty.

In the formation of viaducts brick and stone are sometimes combined. At Stockport, on the Manchester and Birmingham line, is a structure of this kind, consisting of twenty-six semicircular arches: its extreme length is nearly 1800 feet; its mean height, 90 feet. The Dane Valley Viaduct, on the North Staffordshire line, is built

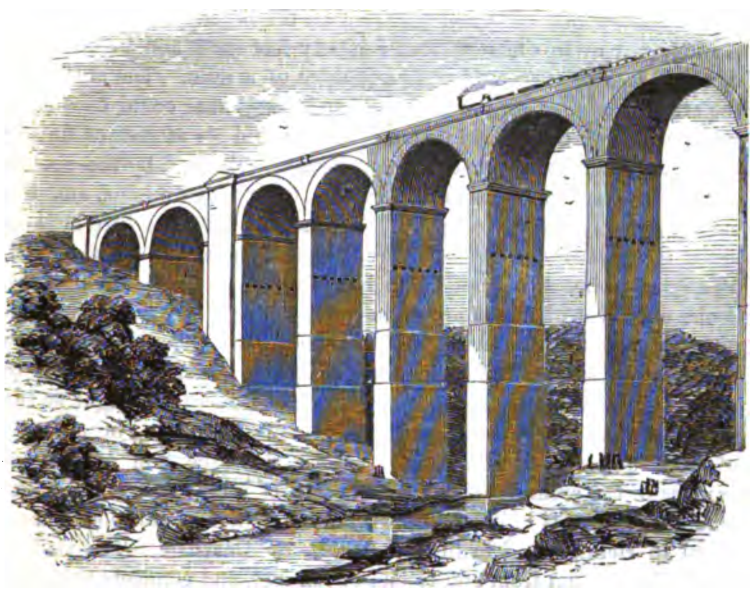
DRYFE SANDS VIADUCT.

almost entirely of brick. The Midland Counties viaduct, across the valley of the Avon, near Rugby, is of the same material. It has eleven semi-elliptical arches, each of fifty feet span; it is characterised by its excess of masonry in the haunches of the arches, and the span of the openings being out of proportion to their height. The Congleton Viaduct (see Engraving, page 163), on the North Staffordshire line, is also of brick. It has ten arches of fifty feet span, and two central ones, which are among the highest in the kingdom. The rails are 114 feet above the bed of the river.

The shape and construction of viaducts depend on the exigencies of the particular case, and the preferences of the engineer. The Dinting Viaduct, on the Sheffield and Manchester line, has been reared on seven stone and five timber arches, the latter being of 125 feet span, and more than 120 feet high. On the same line is the Etheron Viaduct, of stone and iron. The foundations of the piers and abut-

VIADUCT ON THE MIDLAND RAILWAY, NEAR RUGBY.

ments are laid on the solid rock, and 200,000 cubic feet of millstone grit were employed in its erection. Of timber there were more than 30,000 cubic feet consumed, which had previously been rendered impervious to dry rot and the attacks of insects by a chemical process; the iron that was used amounted to more than eighty tons. The Ogwen Viaduct, on the Chester and Holyhead Railway, is also well deserving of notice.



CONGLETON VIADUCT.

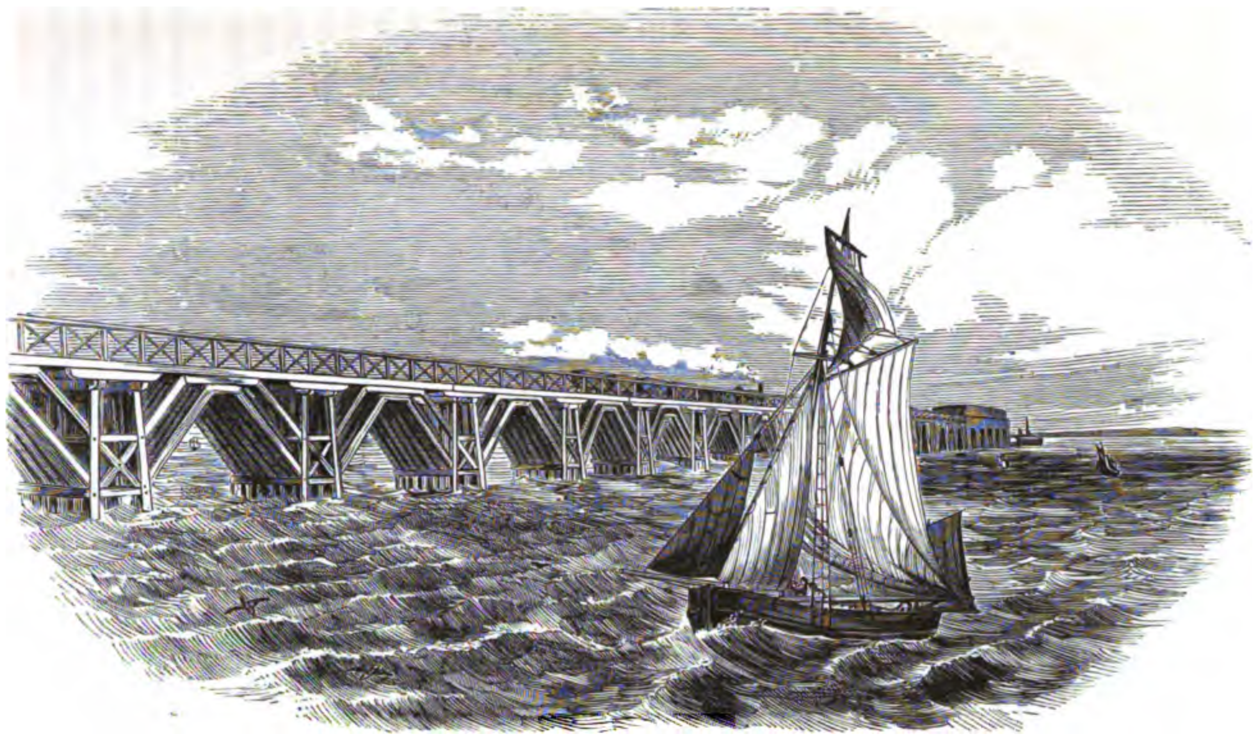
A viaduct characterised by great lightness and loftiness crosses the valley of the Foord near Folkestone. It consists of nineteen arches, some of which are a hundred feet high, and yet the piers are not more than six feet in breadth, or one-fifth of that of the arches. A remarkable skew viaduct of thirty-one arches crosses the Ogden stream and valley. It traverses the chasm between the rocky sides of the river, close to which, in the works, was a quicksand fifty feet deep. Into this the contractors threw earth at the rate of fifteen hundred cubic yards per day, for a considerable time, without any satisfactory result: this was the largest amount ever deposited in a similar space with so much rapidity.

One of the largest viaducts in the country is that traversing the Ouse valley and river, on the London and Brighton line. It consists of thirty-seven arches, the rails, at the highest part, being a

hundred feet above the level of the water. Its length, including the abutments, is 1437 feet.

One of the most daring and stupendous efforts of skill and art to which the railway has given rise is the great viaduct across the valley of the Dee, in the vale of Llangollen (see Vignette in title-page), the dimensions of which are beyond any ordinary effort of the mind fully to realize. It is upwards of a hundred and fifty feet above the level of the river, being thirty feet higher than the Stockport Viaduct. It is supported by nineteen arches of ninety feet span, and its length is upwards of 1530 feet, or nearly one-third of a mile. The outline of the structure is perhaps one of the handsomest that could have been conceived, both as regards its chaste style and its attractive finish; while its general appearance is considerably enhanced by the roundness of the arches, which are enriched by massive quoins, and the curvilinear buttress of the piers. This style of architecture imparts grace and beauty to the structure, without impairing its strength. The greatest attention seems to have been paid to the abutments,—the only part of the erection, in reality, where any decorative display could be made. In the middle of both, on each side, there are beautifully-executed niches in the Corinthian order, in addition to some highly-finished masonry. The piers are neatly wrought at the angles, and at the base of nearly all there is a bedding of upwards of 460 square feet of masonry. With the exception of the entradoes of the arches, which are composed of a blue sort of brick, the whole structure is built of beautiful stone, if not as durable, at least equal in richness and brilliancy to that of Darydale. The viaduct has an inclination from end to end of ten feet, and connects that part of the Shrewsbury and Chester Railway between Rhos-y-Medre and Chirk. Viewed from beneath, the vast structure presents a truly noble and grand appearance, while its bold proportions cannot fail to elicit the admiration of the most indifferent beholder.

The New Holland Ferry, on the Humber, represented in the accompanying Engraving, may be regarded as a viaduct-pier. It extends no less than 1500 feet into the river, and over it the trains pass till they come alongside the express steam-boat, which conveys the passengers and goods across the arm of the sea at a rate of about fifteen miles an hour to a similar ferry on the other side. Instead of the formidable difficulties and numerous annoyances which would otherwise attend the transit; instead of stumbling over wet stones, slipping along greasy landing-places, and getting in and out of boats, the trans-shipment is easily and securely accomplished: the most timid feel secure, and the most fretful can scarcely complain. The



NEW HOLLAND FERRY.

facilities likewise afforded for the conveyance of goods are of great importance in obtaining their rapid and safe transmission.

It is always important, and especially so where the arches of railways have to be converted into warehouses or dwellings, as is the case on some lines, to render viaducts or bridges impervious to water. This is sometimes effected by puddling with clay,—a mode which seldom fails, if it be well executed. Draining, by pipes passing through the piers, has been tried; but it is said not to succeed. A method that has been found advantageous is to coat the arches with a mixture of coal-tar and lime, or with coal-tar alone; in which case the tar should be boiled previously for ten or twelve hours, to evaporate the water and ammoniacal liquor which it contains. The surface of the brick-work is swept clean before the tar is applied; and it is found better not to lay it on in wet weather. Asphalte has been used in several instances, and with complete success; but it is more expensive than coal-tar. The arches of the Greenwich Railway Viaduct, which were originally erected without any efficient protection against the percolation of water, have been made dry by the application of this cement. Coating the arches with sheet-lead is another efficient cure; but it is too costly for ordinary use.*

In 1842, Professor Vignolles estimated the cost of brick or stone viaducts, averaging about a hundred feet in height, to be from £60 to £70 per yard forward, or about 33*s*. per foot in height; and he stated the expense of those formed of timber arches, on stone piers, constructed by him on the Sheffield and Manchester and other railways, which averaged from seventy to one hundred and thirty feet in height, to have been from £35 to £80 per yard forward;—the first-named being the minimum cost, and the latter the maximum. Now, viaducts constructed on the principle of a trussed beam, and in which the piers have no thrust to sustain, may be erected at much less cost than those formed of arches; and it is stated that the former could be, and have been, executed as economically in Great Britain as in America,—the cheapness of timber in America being counterbalanced by the high price of labour.

BRIDGES form an important feature in railway architecture; and some of the most extraordinary engineering works of the present day are of this kind. When piers are required in the stream for the support of the arches of these structures, it is important that they should be placed as nearly as possible at right angles to the current

* Penny Cyclopædia.

of the water; and they should be made convex towards the stream, for their better resistance to floods. The position of a bridge should not be at so narrow a part as to imperil either the works or the navigation; for the contraction of the water-way increases the depth and velocity of the current. It is also usual to construct bridges with an odd number of arches; for the stream being generally most powerful in the middle, an egress through that part is best provided by having a central arch.

The earliest stone bridges had semicircular arches, from their facility of construction. But an obvious disadvantage consists in their having a great rise; and hence the flatter segmental or elliptical arch, depending on abutments, and yielding more water-way with less rise, has been gradually substituted. Of structures of this kind, London and Waterloo Bridges are illustrations. For arches of larger span cast-iron was soon found to be best, owing to its rigidity; and Southwark Bridge may be mentioned as an example. The enormous amount of material required in the construction of such bridges, directed the attention of Telford to the Catenarian principle,—the cheap, light bridge of semi-civilized nations; and he reproduced, at the Menai Straits, in iron chains, the hide, rope, and basket-work structures that span the chasms of Chili, Peru, and Eastern India.

Comparatively few railway bridges are erected for the purpose of traversing water, this being usually accomplished by means of viaducts. They are almost exclusively employed to carry lines over common roads, or for conveying common roads over lines, so that there may be no interference with local traffic. Stipulation is frequently made between the parochial authorities or the landowners and the Company, for the erection of these structures, before the Act of Parliament is obtained, under penalty, if the demand be not complied with, of opposing the progress of the Bill. The necessity for bridges is, however, frequently overstated; and after an agreement has been entered into for their construction, because of their absolute necessity, the owners have in some cases accepted a sum of money equal to half their cost, and consented to forego the erection. Thus two railway authorities have been subjected to great inconvenience and expense in the construction of skew bridges, which a slight and unimportant deviation of the turnpike-road would have rendered unnecessary. "One of the most serious instances of the abuse both ways,—that is, building and not building bridges,—that we recollect, is the entrance of the South-Western into Southampton, where the proprietors of a road leading to a bridge, which is private property and little used, forced the Company, by a chancery suit, to raise a long

embankment and carry a very expensive bridge over the railroad, while, half a mile further on, it crosses, *on the level*, three or four much-frequented streets and roads in the suburbs of the town. The bridge could have been well spared where it has been erected, and would be most beneficially placed over one of the other communications."

It has been affirmed that corporate bodies have no consciences, and that, in their collective capacity, they frequently do deeds that any individual of them would blush to acknowledge as his own act; and we presume that, bearing in mind this principle, and for the sake of equality, individuals sometimes find it necessary, in dealing with them, to lay aside, *pro tempore*, the inconvenient requirements of moral obligation, and then each can deliberately take in the other to the full extent of his ability!

The number of bridges erected over or under local roads, and for field communications, is surprising. Sometimes "cattle arches" are also constructed, under which farmers may drive their flocks and herds, instead of running the risk of attempting to take them over the embankment. There are no fewer than 160 bridges over, and 110 under, the London and Birmingham line; on the Dover Railway there are 141; and between London and Gosport, on the South Western line, there are 188; making a total of nearly 600 bridges on 287 miles of railway. The number of works which it is necessary to construct within a short distance is in some cases astonishing. Thus, between Brentwood and Colchester, on the Eastern Counties line, a distance of less than thirty-four miles, there are no fewer than sixty-four bridges and viaducts, thirty-seven culverts and drains, besides eighteen level crossings.

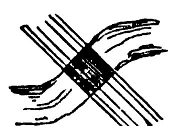
The foundations of large bridges are usually laid by means of cofferdams, which consist of inclosures made by "piling" round the space that is to be occupied by the pier, so as to render it water-tight. The water is then pumped out, and the pier gradually built up to the level of the river. On one occasion Mr. Brunel wished to ascertain whether there was a proper foundation for the piers of a bridge which it was proposed to construct, and he ordered a wrought-iron cylinder to be made, eighty-five feet in length, and weighing twenty-eight tons, which should serve the purpose of a coffer-dam. By the aid of this contrivance it was found that beneath a depth of twelve feet of mud there was a solid mass of rock, capable of sustaining any required weight. Several persons descended to the bottom of the cylinder, and the success of the experiment was in every respect complete.

The cost of the repair of railway bridges is not in general nearly

as much as of those on common roads, which usually traverse rivers, and are therefore liable to have their foundations injured or destroyed by the action of the water. The expense of land bridges is almost confined to the fresh pointing of the joints with mortar or cement, which is an item of little moment in the current outlay.

There are cases of frequent occurrence, in which railways either cross or are crossed by roads or canals in an oblique direction; where, on account of the difficulty or impossibility of constructing a square bridge, the only practicable alternative is to employ a form of arch which is placed obliquely to the abutments. Such a structure is called a skew bridge, and it has been very frequently adopted since the more general introduction of railways.

If a common square bridge were to be employed instead, then the roads intersecting the railway would have to be so diverted as to



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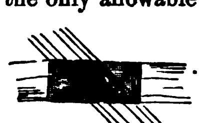
cross at right angles, as in fig. 1, which would frequently be incompatible with the particular circumstances of the case; or the arch must be built stretching at right angles to the lower passage (fig. 2), and having its embankments and abutments so much extended that the entire structure may both stand securely, and furnish sufficient area above for the upper passage to continue its oblique course over it unaltered. An arch partaking of both these forms might, it is true, be employed; but to such expedients a proper skew bridge is in general greatly preferable, and is, indeed, sometimes the only allowable form of construction that will serve the purpose



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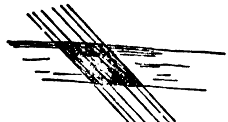
required. (fig. 3.) The wide, or broad arch, too, is a most unscientific mode of overcoming the difficulty. Room for it, with the requisite embankments, could not always be obtained, and it would also greatly increase the expense, owing to the necessity of constructing a bridge of much larger dimensions than would be required were a proper oblique arch introduced, which, from its exerting its thrust in the most advantageous direction, is stronger than any other of the same magnitude. For besides en-



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deavouring to preserve a certain degree of equilibrium among the several parts of an arch, it is considered still more necessary for insuring the greatest strength, especially where the span is considerable, and the upper passage narrow, that the beds of the courses of the stones should be everywhere at right angles, both to the soffit, or under surface of the arch, and also to every vertical plane running in the direction of the road

carried over the bridge. There is no difficulty in fulfilling or combining these conditions in a square bridge, but it is different with the oblique sort. Of the kind of bridge which is commonly employed to obviate these difficulties, and to secure the greatest advantages, the accompanying engraving of Winkwell Skew Bridge is an illustration.

WINKWELL SKEW BRIDGE.

The larger bridges on our railways usually traverse rivers or canals; the smaller ones cross common roads. These are sometimes handsome erections. One of the best finished of them is near Rugby (see p. 172), of yellow brick, with stone dressings, and is a clever adaptation of the castellated style. As viewed from one side, some of the arches of the large Midland Viaduct appear in the distance. Bridges of this kind, however, are not common, it having been ascertained that such works may be erected more economically by means of iron girders, as is the case with several railway bridges which cross streets in the metropolis.

One of the most remarkable structures in the country, of the kind, is the bridge which carries the Great Western line over the Thames at Maidenhead. It is composed of a central pier and two main arches, flanked at either end by four smaller openings, intended for the passage of the water during floods. The main arches are

elliptical, 130 feet span, and 24 feet rise. The land arches are semicircles of 28 feet diameter. The central pier stands in the middle of the river. The foundations of the bridge rest on a hard pebble conglomerate, overlying the chalk, and covered up by loose gravel and alluvial mud. The body of the work is executed in brick; the cornice, cap-stones, and coping are from the quarries of Bramley-Whitehurst, near Leeds. The bridge has this peculiarity—

RUGBY ROAD BRIDGE.

it consists of two arches only, and these are probably the largest, and certainly the flattest, in proportion to their span, yet executed in brick. Its structure was minutely commented on at the time, and many absurd misrepresentations were made in reference to it.

MAIDENHEAD BRIDGE.

The reason of its construction with two arches instead of a greater number was the existence of a shoal, affording an excellent foundation in the middle of the river, and the necessity of leaving the sides and deeper part of the stream open for navigation. On the other hand, the importance of preserving the gradients of the railway uniform, governed the height of the arches.

There is a kind of bridge on the South Coast Railway which is worthy of notice. It is over the Arun, below Arundel, and is the first of its kind. At this point the Company was bound to leave a clear water-way of sixty feet for the passage of shipping, and this had to be accomplished by a contrivance called a *telescope bridge*. The rails, for a length of 144 feet, are laid upon a massive timber, platform, strengthened with iron, and trussed by means of rods, extending from its extremities to the top of a strong frame-work of timber, rising thirty-four feet above the level of the road-way in the middle of the platform, the framework being ornamented so as to appear like an arch. Beneath this central framework and one-half of the platform are mounted eighteen wheels, upon which the whole structure may be moved backwards and forwards, so as either to be quite clear of the river, or to project its unsupported half across it, to form a bridge for the passage of the trains. To provide for moving this platform, when it is necessary to open the water-way, a second portion of the railway, sixty-three feet long, is laid upon a moveable platform, which may be pushed aside laterally, while the

DRAW-BRIDGE OVER THE ARUN.

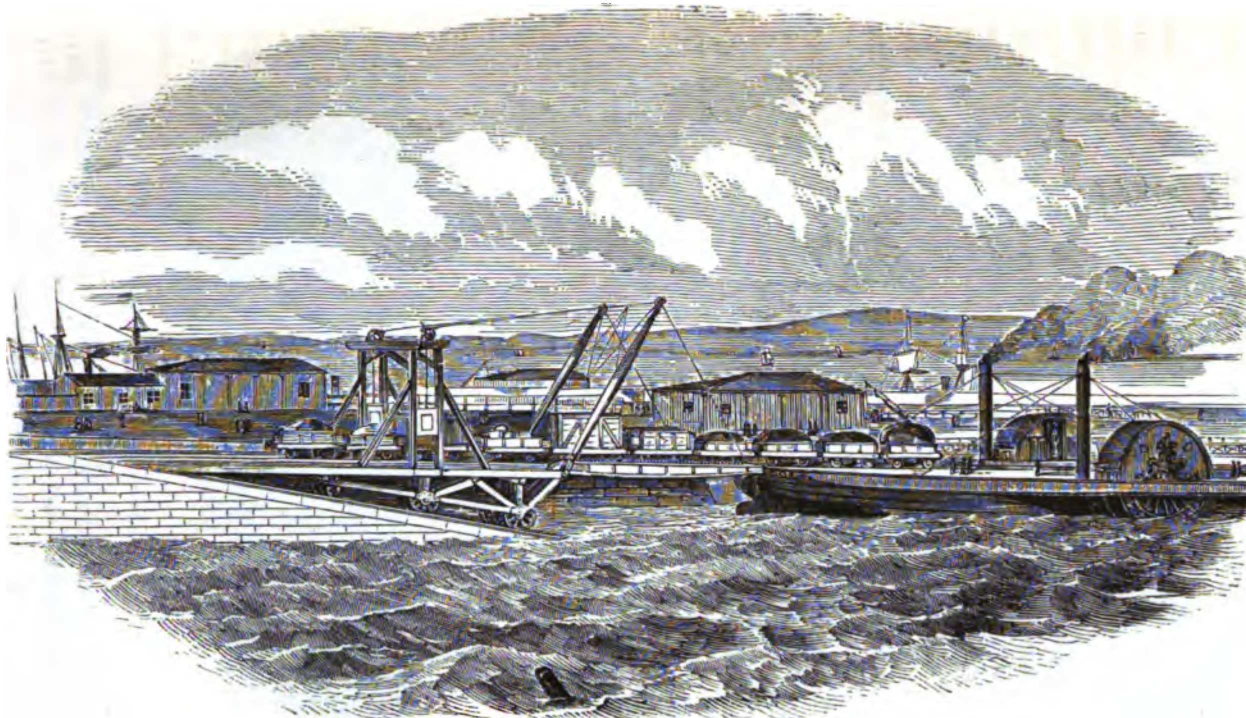
end of the larger platform is pushed longitudinally into its place. Two men and a boy are able to open this bridge in about five

minutes, the operation being performed by means of toothed wheels and racks, wrought by winches.

A steam-bridge, or floating railway, recently constructed to cross the Forth, between Granton and Burntisland, on the Edinburgh, Perth, and Dundee line, deserves special notice. The difficulties that had to be overcome to obtain uninterrupted communication between the two portions of railway were considerable. As the tide rises about twenty feet, a vessel on a level with the quay at high water would be a long way below it at low water; and some special means had, therefore, to be adopted of putting carriages and wagons on board, that they might be transported to the other side. Hydraulic or steam cranes were, it is said, first proposed, by which they might be raised or lowered; but it was found that this would be too slow and expensive a process, and that danger would also be incurred of injuring the vehicles. A floating bridge was next suggested; that is, a set of girders and beams, having one end hinged on shore, and the other attached to a float, to rise and fall with the tide. This, it is considered, would have fully answered the purpose, were the water always smooth; but in stormy weather it would have required protection by means of expensive piers and jetties.

The plan that has been adopted was designed and executed by Mr. Bouch, the manager of the line. Alongside the piers at Granton and Burntisland an incline of masonry has been built, upon which are laid two lines of rails of the usual gauge. Upon this incline a heavy moveable platform is placed, sixty-one feet in length by twenty-one in breadth, and resting upon sixteen wheels. To the front of the platform are attached, by means of universal joints, four malleable iron girders, thirty-five feet long, constructed of boiler-plate, spanning the requisite distance from the platform to the vessel, and affording sufficient depth of water for the keel of the steamer to clear the surface of the slip. These girders are elevated and depressed for the arrival and departure of the vessel, by means of a winch on each side of a staging, eighteen feet high, erected across the platform. The whole structure, with the girders, is raised or lowered to suit the different heights of the tide, by means of a small stationary engine, which is also employed in moving the trucks off and on board the vessel.

The arrangements are made in so complete and efficient a manner, that the vessel can be loaded or discharged with the greatest facility, —five minutes being sufficient to place on board thirty or forty wagons, or to remove them from thence to the shore.



FLOATING RAILWAY ACROSS THE FORTH.

The steamer itself is of peculiar construction. It being necessary that the middle of the vessel should be kept clear for the trucks to stand on, the engines are placed apart, each one driving its own paddle; for if they had been united, the shaft would have been several feet above the deck, and would have allowed only half of it to be loaded at a time.

Upwards of twenty loaded railway-wagons and a passenger carriage have been placed on the vessel and ferried across the Forth at once without difficulty, and yet the steamer was only half loaded, there being no more carriages at hand to put on board. With a strong wind from the north-west, and a heavy swell in consequence, it was expected that some inconvenience might arise on the occasion referred to; but the steamer proceeded across as smoothly and steadily as if the sea had been calm and placid. This mode of crossing the Forth without changing carriages, is expected to render this the most agreeable route to and from the north of Scotland. Goods, minerals, and live stock are also taken across without change of trucks; and thus a continuous line of railway is established between London and Aberdeen. The goods traffic on the floating railway is said to have been opened by the transit of four hundred tons of turnips.*

The high-level bridge at Newcastle-upon-Tyne is a very remarkable structure. It forms the junction between the York and Newcastle and the Newcastle and Berwick Railways. It was projected by Mr. Hudson, and designed by Mr. Robert Stephenson, and extends from

THE HIGH-LEVEL BRIDGE AT NEWCASTLE.

the Castle-garth on the north, to the high ground on the south side of the river. There are two roadways,—one level with the Castle-

* Illustrated London News.

garth, for carriages and foot-passengers, and the other at an elevation of 22 feet above it. The carriage-road is 1380 feet in length, on a straight line. The bridge is 112½ feet from high-water line to the top of the parapet, and the roadway is 80 feet above the water. Six arches, each of 125 feet span, form the bridge,—the piers upon which they rest being of masonry, and the arches, pillars, braces, and transverse girders of iron. The bridge-piers are nearly 50 feet by 16 in thickness; and in extreme height are 131 feet from the foundation, having an opening in the centre through each. They are erected on piles, which pierce the bed of the river about 50 feet on the north side and 20 on the south. The land-arches of the bridge diminish in altitude from the foundation upwards, corresponding with the steep bank of the river-basin.

The roadway for vehicles beneath the railroad forms one of the most striking and novel features of the design. This roadway is suspended from the great arches which carry the line; and it is scarcely possible to imagine a more interesting or beautiful sight than it presents, with the huge span of the arches diminishing in perspective, and the opening at the furthest end of the bridge showing only like a bright spot in the distance. The pillars, which carry the road, add greatly to the picturesque effect; and the multiplicity of column-ribs, transverse and vertical braces, produces such a combination of beautiful lines as is seldom seen.

The Conway tubular bridge, which has deservedly attracted much attention is, in reality, a rectangular tunnel, or hollow square box, having top, bottom, and sides. Around each end is a great deal of wrought-iron work, for the purpose of giving strength to the whole structure, the work at the top, bottom, and sides having each a separate office to perform. It is this part of the work in which Mr. Stephenson's scientific knowledge is specially displayed: the iron-work above the tube consists of eight square cells or tubes, and has to resist compression; that below the tube consists of six cells, and has to resist tension; and that at the sides has to secure the combined action of the top and bottom. The Conway end of the tube is immovable, being fixed on the pier, and made to rest on two beds of creosoted timber with intermediate cast-iron bed-plates; but the Chester end is free, so that it may expand by heat and contract by cold, as the tube rests on cast-iron rollers, which give play so as to allow twelve inches of motion. The whole mass weighs 1140 tons.

A tubular bridge has been constructed over the Wye, at Chepstow, on the South Wales Railway, to which allusion must be made. This bridge consists of four spans, three of about a hundred feet each, and

one of 290 feet, extending altogether from bank to bank for 610 feet. The three smaller spans rest upon iron piers, filled with concrete, supporting cast-iron girders, on which the railway is laid. The fourth or chief span is made upon the suspension principle, the great length of the girders requiring more support than that afforded by the piers alone at each extremity. Mr. Brunel accordingly contrived that this should be accomplished by means of a tube 309 feet in length, and nine in diameter, which, having been raised to the summit of piers erected on the east bank, and in the centre of the river, is strengthened by massive chains secured to the girders. These girders are fifty feet above high-water mark at spring tides, which here rise from fifty to sixty feet—a greater height than in any other river in the kingdom.

In commencing the operation of sinking the cylinders to form the piers of the bridge, the workmen had first to pass through twenty-nine feet of blue clay and sand, below which they met with a thin bed of peat containing timber, some solid oak, hazel nuts, and other substances of a like nature. They next came to several feet of fine blue gravel, and then found the bed of boulders, upon which the cylinders were originally intended to rest. After this was a bed of red marl, beneath which they discovered solid rock, resembling what is known as millstone grit, into which the cylinders were sunk. The mode in which this part of the work was performed was very curious. The cylinders were placed on planks to prevent their cutting into the soft mud. One by one cylinders were added until they had reached the top of the stage, about forty feet in height, which had been erected for the purpose of sinking the cylinders. The weight of the column then cut throught the plank, and the cylinder sunk about six feet into the mud. Men then descended into the cylinder, two or three working there at a time; and as they excavated the soil, so the cylinder gradually sank, and as the column descended, fresh cylinders were added at the top. The excavation then continued, without interruption, until a depth of about seventeen feet was attained, at which point the water broke in from below in such force as to require the constant operation of two thirteen-inch pumps worked by an engine. The water burst in at a moment's warning as soon as the spring was tapped; and the most remarkable phenomenon attending this occurrence was the fact, that the spring-water invariably rose in the cylinder exactly to that height at which the tube was standing in the river at the moment. That it was not an irruption of the water from the Wye is considered to be beyond dispute, inasmuch as the river at this point is, from the action of the tide,

always tainted with mud, which is held in solution in great quantities at all times, while the water which rushed into the cylinder from below was of exceeding purity and contained not a particle of salt.

From the period when the spring was first tapped, the pumps were obliged to be kept at work until the cylinders had been sunk to the rock; they were then filled with concrete. This irruption of water at a depth of seventeen feet from the surface of the bed of the river was the same in the sinking of all the cylinders for the centre or principal pier; but the water did not interrupt the works to so great an extent in making the other piers, and the workmen penetrated to a greater depth. The spring appeared to be in the bed of gravel, about twelve feet from the point where it first burst into the cylinder.

On the various interesting processes by which the tube was floated to the piers, and ultimately raised to their summit, we shall not dilate; as reference will have to be made to similar means, and on a larger scale, in describing the construction of the Britannia Tubular Bridge.

The Britannia bridge, uniting the shores of North Wales and the Isle of Anglesea, is one of the most wonderful structures of modern times. The task of traversing the "great tidal chasm" which forms the Menai Straits was committed to Mr. Stephenson, who proved fully equal to the undertaking. His conception was commensurate with the work,—it was, to hang a hollow iron tunnel across the arm of the ocean, capable of supporting the heaviest burdens that passing trains could impose, and of bidding defiance to the storms which "eddy and whirl" along the Straits. To accomplish this gigantic project, a long series of laborious and costly experiments were made to ascertain, apart from all preconceived notions, the strongest form for a sheet-iron tubular bridge. In these investigations, it was found that cylindrical tubes failed by collapsing at the top, and that they were inferior in strength to those of an elliptical form. Rectangular tubes were next put to the test, and they had so decided an advantage in point of strength, that the precise form and dimensions only remained to be determined. A new "model" was accordingly constructed one-sixth of the size of the proposed Britannia Bridge, and the final experiments having terminated in a most satisfactory manner, arrangements were made for the erection of the colossal structure.

The "iron tunnel" which has been thrown across the sea, is supported on three piers; two on the Carnarvon and Anglesea shores, and one on a rock in the centre of the Straits. The Britannia tower, as the last is termed, rose gradually and majestically from the surface of the water to the height of 230 feet, and the piles of masonry on land are of the altitude of more than 160 feet. The tower was con-

structed of 148,625 cubic feet of Anglesea marble for the exterior, and 144,625 feet of sandstone for the interior, strengthened by 387 tons of cast-iron beams and girders, and having a total weight of upwards of 20,000 tons. It was originally intended that the pier should be crowned with a colossal figure of Science; but the depreciation of railway property induced the Directors to postpone, if not to abandon the design. The land abutments on each side of the Strait are terminated by two couchant lions of Egyptian character, each weighing eighty tons, and which required no less than 8000 cubic feet of limestone for the formation of the four.

While the piers and abutments were thus progressing, the construction of the tubes was prosecuted with vigour. A timber platform was erected along the side of the water, behind which were the workshops of the artisans, covering three acres and a half of ground. On this platform the plates were secured one to another, in a similar manner to that adopted in the construction of iron ships. The plates varied in their dimensions according to the portions of the tubes for which they were intended, being from six to twelve feet in length, about two in width, and from one-half to three-quarters of an inch in thickness. Though they had been forged with the greatest accuracy, yet each was made to pass between two enormous iron rollers, worked by steam, which squeezed down into perfect uniformity that variety of irregularities to which the workmen have given the term of *buckles*. The plates were then removed to a punching-machine, by which the rivet-holes were made. The lever by which this was performed was endowed with a pressure of from sixty to eighty tons; and the iron plates were perforated by the steel bolt with apparently as much facility as a child would force its thumb through a piece of blotting-paper. The rivets employed in securing the plates together were no fewer than two millions in number, in the formation of which 126 miles of iron rod were used, which weighed about 900 tons. Each "length" of iron had a head formed at one end, and was then returned to the furnace to be used by the "tube-men." As the bolts were required, a lad snatched up one of them with a pair of pincers, and then flung it to another boy inside the tube, who picked it up, and ran with it to the "holder-up." This man forced it into the rivet-hole by the beating of an enormous hammer till its head protruded through to the other side, when it was beaten by a couple of strong and stalwart workmen who soon moulded the other end into a head, and thus the bolt was reduced to a rivet. This gradually cooling, bound the plates of iron together with so much force, that a pressure of from four to six tons on every

one would be required to cause them to give way. Practice, however, gave such facility to the men, that a set drove 230 rivets a day there being about eighteen to a yard.

The spectacle presented during the progress of the works was novel, interesting, and impressive. Ship-loads of iron continually arriving from Liverpool, of Anglesea marble from Penmon, of red sandstone from Runcorn, and forests of timber from a variety of ports, discharged their cargoes at the wharves and platforms; and wagons and carts incessantly travelling in all directions, on tramways and common roads, combined to form a remarkable spectacle; while vast clouds of dark smoke issuing from chimneys; steam-engines constantly at work, pouring forth volumes of steam high into the air; the whirring of machinery, the explosion of gunpowder, the thunder-like clang of the blacksmiths' hammers at the forges, and the reverberation from those at work along the tubes where the rivetters were securing the plates, formed an extraordinary chaos of both sights and sounds.

The masonry of the piers and abutments being at length sufficiently advanced towards completion, and one of the tubes being finished, arrangements for "the floating" were made,—an operation which attracted an immense concourse of visitors from all parts of Britain, Europe, and even from the United States.

In the mean time the platform, which supported the first tube that was to be removed, was partly cut away at each end, and a dock excavated, sufficiently large to contain four pontoons, at either side, of nearly 100 feet in length. Till the completion of the tube, these vessels lay at the bottom of the water, waiting till their gigantic energies were required to bear away the unwieldy burden. The combined power of floatage of the vessels amounted to no less than 3200 tons, while the weight of the tube, with its apparatus, was only 1800. On the day appointed for the floating, the valves in the pontoons, which had previously admitted the water, were closed, and as the tide rose, they rose with it, and ere long bore the tube from off the platform on which it had been constructed. The capstans on the Anglesea and Carnarvon shores and at the Britannia pier were fully prepared; cables, six inches in diameter and a league in length, were arranged in their required positions, or attached to the steamers which were to have the towing of the tremendous freight; a hundred seamen, under Captain Claxton, manned the vessels; nine hundred men assumed their several posts, and the vast and complicated arrangements were complete. As the gunwales of the vessels, like the shoulders of Atlas, received the weight of the tube, the land-attachments were severed, the capstans

manned, and, as the signal was given by the display of a flag on the Anglesea side, and a shrill strain from the trumpet of Captain Claxton, from the top of the tube, "to pipe all hands" an enthusiastic cheer arose from the seamen, whose efforts, aided by the steam tugs, told upon the screws and tackle, and upon the hitherto motionless monster; and it slowly glided away, amid thunders of increasing applause, without injury or jar, and with a majesty that seemed only comparable to that of a mountain moving on the waves to the foot of the towers on which it had ultimately to repose.

Such was the completeness of the arrangements, and such the efficiency of their execution, that, despite the power of the tide and the shortness of the period in which the work had to be completed, that the mass was deposited in its intended position, leaving a clear space of only about three-quarters of an inch. The undertaking having been thus far accomplished, the valves of the pontoons were partially opened, and the vessels, sinking to the bottom, allowed the ends of the tube slowly to descend to the respective resting-places which had been prepared for their support.

The next process in this extraordinary operation was the elevation of the tube to its position at the summit of the piers,—a work which was performed by the agency of Bramah's press. The press was securely fitted in the upper part of the Britannia tower, at a height of about 40 feet above the level to which the tube was to be raised. Connected with the top of the piston of the press was a horizontal iron beam, from the extremities of which hung two enormous iron chains, of the weight of a hundred tons, by means of which the tube was lifted to the place of its destination.

The preparatory arrangements having been completed, and two forty-horse power steam-engines applied, a lifting force was gained of no less than 2622 tons; and then the great piston began slowly to emerge from the cylinder, until in about thirty minutes the entire mass of chains and bridge was elevated six feet into the air. The tackle was then secured by "clams" at the foot of the press, and the weight removed from the piston, which descending by its own gravity to the point from which it started, the lifting operation was repeated; and as the other end of the tube was treated in the same way, the whole was gradually elevated to the summit, the final lift of the first tube being made on the 13th of October, 1849.

This bridge, which has been characteristically described as an iron tube hung across an arm of the sea, was opened on the 5th of March, 1850, by the passage of three powerful engines, decorated with the flags of all nations, and conveying the distinguished engineer, with

other gentlemen of eminence. The train started at Bangor station, and, at seven o'clock in the morning of that memorable day, swept over the threshold of the stupendous fabric, and was soon lost amid the darkness within. The locomotives, weighing ninety tons, were stopped on reaching the centre of each of the great spans, and rested, with the weight of all the wheels, on the floor of the tube, without occasioning the slightest strain or deflection. It required next to be ascertained how far the vast corridor was capable of sustaining the equilibrium of forces; and the result was such as to prove beyond doubt the accuracy of the theoretical conclusions at which Mr. Stephenson and his staff of engineers had arrived. The second experimental train that went through consisted of twenty-four heavily-laden wagons, filled with blocks of Brymbo coal, and making an aggregate weight of three hundred tons This was drawn through the tubes with deliberate speed. During the passage, a breathless silence prevailed; but when it emerged at the opposite end, loud acclamations arose, while the report of pieces of ordnance smote on the ear. The examinations were thus continued for a considerable time; and the weights that were applied served only to demonstrate the stability of the fabric. A train of two hundred tons weight was next placed in the middle of the Carnarvonshire tube, and remained there for two hours. It was found, on its removal, to have occasioned a deflection of only four-tenths of an inch; and it is worthy of remark, that an equal curvature would have resulted from half an hour's sunshine, while it is confidently estimated that the entire structure might be deflected to the extent of thirteen inches, without danger of accident. Another testing-train was subsequently formed, comprising three engines, two hundred tons of coal, and from thirty to forty railway carriages, containing between six and seven hundred passengers. The tube was traversed by these at a speed of thirty-five miles an hour.

The various trials to which the tube was subjected, by Mr. Stephenson and his agents, and by Captain Simmons, the Government Inspector for the Railway Commissioners, were in the highest degree satisfactory. The arrangements that had been made for maintaining continuity in the entire length of the tube were also perfectly successful; for, by the conjunction of the several portions the strain on any one part was distributed over the whole; and thus, as the engines entered the small land-tubes at either end, the motion due to their progressive weight was detected in every tube, even at the distance of 1560 feet. The strength of the bridge is indeed sufficiently demonstrated by the fact, that according to the estimate

BRITANNIA TUBULAR BRIDGE.

of the engineers, it would be capable of supporting a load of locomotives piled one on the top of the other over its whole surface, or that a line-of-battle ship might be suspended from it without danger.

The appearance of the bridge is very imposing. Could the reader stand upon the shores of the Isle of Anglesea, and view the entire spectacle, though but for a few moments, on some fine spring evening, he would retire with impressions of its magnificence which neither pen nor pencil can create. Extending in the far distance is the undulating landscape, varied by the rich tints of the woodland, and backed by rising hills; while the sun, approaching the verge of day,—

> "Wearied with sultry toil, declines and falls
> Into the mellow eve; the west puts on
> Her gorgeous beauties—palaces, and halls,
> And towers, all carved of the unstable cloud."

Stretching far away to the east and west, and glittering beneath the sun's rays, are the Irish Sea and St. George's Channel, connected by the Menai Straits; while the steam-vessel and the deeply-laden merchant-man wend their way along. In the distance, towards the Irish Sea, is the slender fabric of the Suspension Bridge, over which some seemingly Lilliputian vehicle and horses are passing. The small islands and rock which impede the progress of the water along the Straits serve to add interest to the scene. To the northward is the Anglesea column, erected by the inhabitants of the neighbourhood in commemoration of the gallant Marquis, who led the British cavalry at Waterloo; while about a hundred yards distant may be seen a humble, but touching monument, built by the workmen of the Britannia tower, as a tribute to the memory of some of their comrades who lost their lives during the construction of the bridge. On the south the view is bounded, at the distance of forty miles, by a range of mountains, the loftiest of which is the well-known Snowdon. Between the base of these hills and the Straits, the little wooden town was erected which served for the accommodation of the artificers and workmen. And now, as we gaze upon this scene of mingled wonders and beauties, the deep-toned reverberation of a train rushing along the iron corridor of the bridge, smites upon the ear; and thus Science and Nature are mingled in harmonious contrast, and receive the grateful homage of every rightly-constituted heart.

A Tabular view of some of the dimensions of the bridge, and some of the quantities of the materials employed in its construction, may serve to give a comprehensive idea of the entire work:—

	Feet.
The total length of each tube is	1,492
Total length of tubes	2,984
Greatest height of the bridge above high-water mark	240
Height of the bottom of the bridge above high-water mark	104
	Cubic Feet.
Quantity of masonry in the piers, abutments, and wing walls	1,400,000
Timber used in scaffoldings	450,000
	Tons.
Weight of malleable iron in the tubes	10,000
Weight of cast-iron	1,400
Weight of one of the two tubes	5000
Cost of one of the tubes	£54,000
Cost of the scaffolding	50,000
Cost of Britannia Tubular Bridge	500,000

The successes of our great engineers may encourage all, at once to hope and to attempt. They have the mind to plan, and the hand to execute; and so have all men, though with different degrees of adaptiveness, and different spheres of action. The ever-varying contingencies of engineering operations are constantly opening new fields on which to exercise ability. In the erection of great works, and, to a still higher extent, in the contrivance and formation of moving machinery, the combination of theory and practice has to be accomplished in a way which affords room for all the resources of man. By accurate calculations and adjustment of opposing forces, and by practical skill in the mechanical details of construction, he must attain abundant strength united with the utmost possible economy of space and weight; and here lies the opportunity for the display of personal ability. There must be no waste of power, no useless and cumbrous weight; there must be a skilful counterbalancing of irregular strains, while the greatest pressure must be sustained by the points of greatest resistance. And thus it is that experience has entitled us to place implicit confidence in the scientific precision of our engineers. Every day we trust our lives and fortunes, without misgivings, in situations where a slight error in the calculations, or a small defect in the workmanship, would inevitably lead to catastrophes on which it is painful to allow the mind to dwell even for a moment. Let, then, past success in these departments of science and art encourage all to the prosecution of higher aims, and the attainment of permanent and more important results.

Far be it from it us to rank ourselves with those who would

circumscribe within some narrow bounds the limits of the exercise of man's inventive powers. To believe this would be inconsistent with the great fact of his nature as a progressive being; and though his resources and his sphere of operation are doubtless finite, yet we must not attempt to declare their boundaries. We avow no sympathy with the spirit manifested by the ancient Geographers, who drew the lines that marked the confines of the then known world upon their maps, and wrote "*nil ultra*" outside. Experience alone can decide the real obstacles that oppose the progress of scientific invention; for while some impediments are objective, and, from the constitution of nature, insuperable, others are subjective, and may be surmounted; and thus, that which seems impossible with one generation, is accomplished by the next. To know where is the barrier, is doubtless a difficult task; but what is left for man is, with zeal and perseverance, to prosecute the task of penetrating from the actual and the known into the broad expanse of the contingent and the unknown.

TEMPORARY BRIDGE.

CHAPTER IX.

Permanent Way—Definitions—A Navvy's Explanation—Ballasting—Anecdote—"The Battle of the Gauges"—Origin of the present Gauge—Mr. Brunel's Gauge on the Great Western Railway—Reasons for the adoption of the Broad Gauge—Other Gauges—Irish Railways—Relative advantages of the Broad and Narrow Gauges—Cost of the Gauges—Evils of a Break of Gauge—Combinations of Gauges—Proposals of Capt. Powell, Mr. Brunel, Capt. Simmons—Sleepers—Stone Blocks—Setting the Stone Blocks—Transverse Wooden Sleepers—Chairs—Wooden Keys—Cost of Keys—Iron Keys—Rails first employed—Cast-iron and Malleable Rails—Proposal for Worming the Rails—Great Western Rails, Bearings, and Tracking—Experiments with Longitudinal and Transverse Sleepers—Curious results—Cast and Wrought Iron Road—Messrs. Barlow's Inventions—Relative Advantages and Cost of the old and new Method—Durability of Rails—Calculations on Belgium and English Lines—Duration and Renewal of the Permanent Way—Cost of Permanent Way—Advance in the Price of Iron—Anecdote of the great Iron Master's Wife, Lady Charlotte Guest—Daily Examination of the Permanent Way—Squinters—Arrangements during the Repair of the Permanent Way—A near Run.

HAVING briefly described the chief works in the construction of a railroad, the permanent way, as it is designated, comes under consideration. The origin of this technical name is not obvious; for the term is applied to that portion of a railway which is the *least* permanent of the whole, and which requires continual watchfulness and frequent repairs to maintain in efficient working condition. The word, however, is not inappropriately employed in contradistinction to the *temporary* way, which is laid down in the first instance to facilitate the construction of the line.

A definition of the term, which was once given by a ganger to Mr. Brunel and one of his' engineers, may perhaps throw some light upon the subject. Shortly before the opening of the Great Western line between Maidenhead and Twyford, the engineer-in-chief visited the works. A siding had been made, leading along an incline to a gravel-pit; from which ballast had been brought for the permanent way, and Mr. Brunel was somewhat annoyed at finding that it had not been filled up. The ganger, who was standing near, was accordingly taken to task; and the inquiry made how it was that the work

had not been completed. It appeared that the ganger had been informed that the incline was to be permanent; but not wishing, it is presumed, to employ language which should be above the comprehension of the engineer, replied, as he doffed his cap and stroked down his forelock—

"Please, sir, I understood as you was a-goin' to have an incline here *for ever!*"

In order to obtain a firm and dry foundation in which the sleepers may be laid, a stratum of gravel, chalk, or broken stone is spread over the road to the depth of two or three feet;—this is termed *ballast*. If stones are employed, they should be so small that they will pass through a ring of two or three inches in diameter; but they are not commonly used. If the ordinary material removed in forming a railroad were used as ballast, many difficulties would arise; for in frosty or dry weather it would be so hard as almost to defy the spade. A line of railway usually traverses either some gravel-pits, or lies in their immediate neighbourhood; and as gravel is not greatly affected by changes of the weather, and is, as the men say, "always workable," it is almost exclusively used.

On the London and Birmingham line are several extensive and valuable ballast-pits, the principal being at Watford, Leighton, and between Rugby and the Kilsby tunnel. The writer was on one occasion standing in the Watford cutting, which passes through both gravel and chalk,—he made some inquiries of one of the plate-layers, in reference to the ballasting, and remarked that the best gravel seemed to have disappeared, and that the remainder was either too coarse or too fine. "Yes, sir," said the man, "they say the Company has got rayther pysoned with it of late;" which appeared, to say the least, to be a novel agency for the commission of wholesale suicide!

If the material from the ballast-pits has to be conveyed for a considerable distance, a "ballast-engine" is employed, the driver of which may be said to be the real opener of that portion of the line, though the opening is supposed to be effected with due solemnity by the Directors of the Company and their friends, attended with the rites and ceremonies of eating a substantial dinner, and drinking bumpers of champaign.

The ballast being spread along a portion of the line, the permanent rails, sleepers, and chairs are then laid down; and as the important question of gauge here arises, a brief consideration of it will be necessary.

The question of the gauges has involved a large expenditure of time, discussion, and money. When the Liverpool and Manchester line was projected, Mr. George Stephenson was appointed engineer

he having previously attained a reputation in the colliery districts, where he had become specially conversant with the formation of tram-roads and the working of engines. The original intention of the projectors of the new line had almost exclusive reference to its use for the conveyance of goods; and hence Mr. Stephenson, seeing no reason to depart from the gauge then generally established, adopted it, and the Liverpool and Manchester Railway was laid down with the gauge of four feet eight inches and a half. The branch lines were necessarily constructed in the same way, since the engines and carriages would have been otherwise unable to pass from one to the other; and when the lines which connected the metropolis with the northern system were made, the same gauge was preserved.

Experience, however, proved that considerable inconvenience arose from the narrowness of the gauge which had been thus selected, for the crowding of the machinery of the engines into the space assigned them produced inconvenience both to the builder and the cleaner; and regret was expressed that the gauge had not been fixed a few inches wider. Further experience, however, showed that these difficulties might be surmounted, and the requisite means for the prevention of the evil were to a great extent provided.

The question was not determined, when a great change took place. Mr. I. K. Brunel, who had been selected by the Directors of the Great Western Railway to superintend the engineering works of that line, suggested that a gauge of seven feet would be preferable. The proposal was startling. When laid before Mr. Robert Stephenson, the engineer of the London and Birmingham line, he reported on it unfavourably. A schism arose between the two Boards on the subject, and it was found necessary to abandon the idea which had till then been entertained of having a common metropolitan terminus for the two lines.

An elaborate exposition of his views upon the subject was made by Mr. Brunel, in several reports which he addressed to the Directors. He admitted that in a continuous line of traffic a departure from the established gauge would occasion inconvenience, and that in the case of the Great Western Railway it would almost amount to a prohibition of communication with another line running north from London. But he considered that as the new line was to be carried through a district in which no railways existed, it could have no connexion with any other of the main lines, and that as the branches would complete the communication with the surrounding districts through which the line was intended to pass, they would be independent of other railways for the traffic they would bring to the main line.

He even maintained that the exclusion from connexion with other railways would be advantageous, inasmuch as it would be a means of securing a monopoly of railway communication in the West of England and South Wales in the hands of the Great Western Railway Company. The Directors were satisfied, and Parliament sanctioned the project by rescinding a Standing Order which had prescribed the narrow gauge for general adoption.

Other gauges were adopted for some other lines. Mr. Braithwaite first chose five feet on the Eastern Counties, and some short Scottish lines adopted six feet. The Ulster Company availed themselves of the recommendation of the Irish Railway Commissioners, and completed twenty-five miles of the way from Belfast to Dublin on the six feet two inches scale; while the Drogheda Company, which set out from Dublin to meet the Ulster line, adopted a gauge of five feet two inches. When this discrepancy was complained of by the Directors of the Ulster line, they were answered by the Irish Board of Works, that though this looked a little awkward, yet, in fact, the two ends being completed, there was little chance of the intervening part ever being finished, and that therefore there was no harm done.* The dispute having been referred to General Pasley, he consulted all the leading authorities, and finally adopted five feet three inches as the national gauge for Ireland, being the mean of all their opinions, which differs from all the three gauges now in operation there.

As regards the accommodation and convenience of passengers, no decided preference can be given to either the broad or narrow gauge; but on the broad gauge the motion is generally more easy at high velocities. In respect to speed, the advantage is also on the same side; but it is considered by high authorities that the public safety would be endangered in employing the broad gauge much beyond its present speed, except on roads more consolidated and more substantially and perfectly formed than existing lines. The narrow gauge presents greater convenience for the transport of goods, and is more suited to the general traffic of the country. Small carriages are of great importance for the extension of agricultural traffic, which has scarcely been touched by some railways. "The traffic of the West of England," says Mr. Sidney, requires "not huge, unwieldy carriages and trucks, but handy wagons, which may without inordinate trouble or expense be run into small road-stations and sidings, to which a farmer may send his couple of fat oxen, or his score of sheep, or his load of corn, in conjunction with one or two more neighbours." He states that of such traffic there has been little on the Great Western

* Report of Railway Deputies, 1843.

Railway, though it traverses rich agricultural districts, because "the whole machinery is on too vast, costly, and magnificent a scale."

The difference in the original outlay between the broad and narrow gauge railways is of great importance, and in this respect the latter have a decided advantage. Two lines of rails of the broad gauge are fourteen feet wide, and two of the narrow gauge are nine feet five inches wide, the difference being within an inch of another track of narrow-gauge railway. Though Mr. Brunel has made his tunnels six feet wider than those on the narrow gauge, yet of this a difference of four feet seven inches is all that is strictly chargeable to the gauge. Where the works generally are unimportant, the increased cost of the land—which amounts to three-quarters of an acre per mile—is not an item of very great moment; but where they are of magnitude, the difference of four feet seven inches in width to every embankment, viaduct, and bridge above ground, and every cutting and tunnel below, forms an amount of considerable importance, and demands a proportionate return in the shape of interest on the capital expended. In short, it is estimated that where a narrow-gauge line would require £6000 per mile, £7000 would in all probability be necessary for the broad; and where the works of art cost, as on the Manchester and Leeds Railway, more than £40,000 a mile, there the broad gauge would *per se* require an augmented expenditure of from £6000 to £8000 per mile, merely from the additional size of the works.

As regards the security of the trains upon the rails under high velocities, much may be said in favour of the broad gauge. The greater width between the wheels necessarily gives increased stability to bodies supported upon them, and thus the oscillation found to attend high velocities on the narrow gauge is avoided on the broad. As illustrative of the steadiness of trains on lines constructed upon the latter principle, the following incident may be mentioned. Shortly after the Great Western Railway was opened to Maidenhead, the engines which were employed were found capable of attaining a very extraordinary speed with light weights; and trains frequently accomplished the entire distance of twenty-two miles and a half in thirty-five minutes, including three or four stoppages at the intermediate stations. A quantity of fish-bellied rails had to be conveyed from the neighbourhood of Maidenhead to some point lower down the line, where they were required, and a train had been engaged in loading and taking them away during the intervals between the passage of the ordinary trains. They were accordingly all cleared off, with the exception of one rail, which was inadvertently left lying

across one of the rails of the down line. Shortly after the removal a train coming from London approached the spot at full speed—for it was just about the distance from Maidenhead at which it was customary to drive at the fastest rate before letting off the steam. The train approached and crossed that terrible bar; but instead of being itself flung from the rails, as would probably have been the case on the narrow gauge, it cut the metal through with its iron tread as if it were a piece of soap, and passed on without injury or shock. The fragments were forwarded to Mr. Brunel as trophies of victory; instead, as under other circumstances they might have been, instruments of fatal destruction.

After all that has been said in reference to the relative advantages of the broad and narrow gauges, it appears that the broad gauge is too broad for economy, and the narrow too narrow for attaining a very high velocity with perfect security. The breadth of the engines and carriages on the Great Western system of lines is such, that the works have to be of a massive character, in order to sustain the extra weight; while the narrow limits of the ordinary gauge do not admit of the full development of the power of the locomotives, they involve some risk of trains running off the rails when at extraordinary speed. But should any alteration be effected, it must be from the broad to the narrow gauge. This would be the necessary course, not only because the number of miles of the former is few compared with the latter, but because the cost would be incalculably less. To adapt the broad lines to the narrow, would be little more than to approximate the rails; but to convert the narrow into the broad, would involve the re-erection of bridges and tunnels, and, in short, almost the re-construction of the lines of the country.

The evils resulting from the break of gauge are by no means unimportant. The inconvenience to passengers is great, but the difficulties as respects the goods traffic are still greater. The removal involves loss, pilferage, detention, besides a money tax, estimated at from 1*s.* 6*d.* to 2*s.* 6*d.* per ton. It is found at Gloucester that it occupies about an hour to remove the contents of a wagon, full of miscellaneous merchandise, from one gauge to another, with all the force of porters that can be brought to act upon it. An ordinary train, laden with "promiscuous goods," may contain "loose commodities, such as bricks, slates, lime or limestone, and chalk, flags, clay, manure, salt, coal or coke, timber and deals, dye-woods, iron, iron-ore, lead and metals, cast-iron pots, grates and ovens, grindstones, brimstone, bones and hoofs, bark, hides and seal-skins, oil-cake, potatoes, onions, and other vegetables; cheese, chairs, and furniture; hardware, earth-

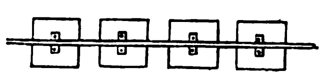
enware, dry salteries, groceries, provisions, cotton wool, oils, wines, spirits, and other liquids; manufactured goods, fish and eggs, ripe fruit, etc., etc., etc. Now let us contemplate the loss by damage done to the goods on this line alone, by reason of the break of gauge causing the removal of every article. In the hurry the bricks are miscounted, the slates chipped at the edges, the cheeses cracked, the ripe fruit and vegetables crushed and spoiled; the chairs, furniture, and oil-cakes, cast-iron pots, grates and ovens, all more or less broken; the coals turned into slack, the salt short of weight, sundry bottles of wine deficient, and the fish too late for market. Whereas, if there had not been any interruption of gauge, the whole train would, in all probability, have been at its destination long before the transfer of the last article, and without any damage or delay." Though this description is somewhat overdrawn, there is still much truth in it. It will be readily imagined that the live stock frequently manifest decided objections to the change of train; and we are informed that pigs exhibit their usual peculiarities of disposition on these occasions, that cattle sometimes resist with great energy, and that two hours have been spent in effecting the removal of one of them.

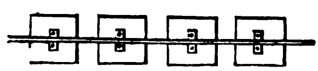
To obviate the difficulties arising from a break of gauge, various proposals have been made. Captain Powell suggested that all luggage vans and horse-boxes should be so constructed that their bodies might be removed from one truck to another, and the narrow-gauge bodies might then be transferred with their contents, and placed sideways on the broad-gauge trucks. The narrow-gauge trucks, however, would be unable to give any assistance to the broad-gauge carriage-bodies.

A combination of the two gauges was proposed by Mr. Brunel, to be effected by "the introduction of a single additional rail to each line of rails, or separate railway, the outer rail of each railway being common to the two gauges." This would admit of the running of all the trains of both gauges into the same sidings, and up to the same passenger platforms. After maturely considering the subject, however, Captain Simmons uses so very cautious and hesitating a style of language, that the change will probably be regarded as introducing the elements of danger to an unwarrantable extent, and to encourage great complication and difficulty! He says, "By avoiding *all* meeting points, by a separation of the gauge in the sidings and stations, and by *most stringent regulations*, preventing, *under any circumstances*, the connecting, in one train, of carriages of different gauges, I *think* the safety of the public will be guaranteed, with ordinary care and supervision, and that the line may, by a strict compliance with these conditions, be rendered practically safe."

Before leaving the consideration of the relative merits of the gauges, it may be well to make brief reference to the individual with whom this subject is intimately associated. Mr. Brunel undertook the important and responsible work of trying a grand experiment in reference to the capacities of the railway system; and with great powers of conception, and unfaltering energy and determination in the execution of the task to which he devoted himself, he overcame the difficulties which lukewarm friends, alarmed proprietors, and avowed enemies, interposed; and has completed an undertaking which, to say the least, has fulfilled many of the promises made in reference to it, and has shown the fallacy of many of the objections urged against it. And as a noble work, colossal and complete in its proportions, it may be fairly regarded as the monumental embodiment of the bold inventive genius, and the energetic and persevering labours, of its originator; who, while called "clever but theoretical," has shown his power not only of conceiving, but of executing the grandest scientific undertakings.

The surface of the road having been previously prepared by the ballast men, the timbers are laid down on which the rails are to be supported. The sleepers are of various kinds, being of stone, wood, or cast or wrought iron. Originally, large numbers of stone blocks were used, being about two feet square and one foot thick; and portions of lines still exist which were made in this way. Thus, on the London and Birmingham line no fewer than 152,000 tons weight were laid, costing about £180,000. This expense is divisible into three nearly equal parts: one-third for the stone, one-third for the freight from the quarries to the Thames, and the remainder for delivery on the different parts of the works.



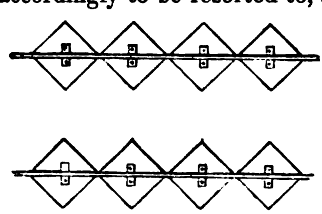


The setting of the sleepers on which the rails rest is a matter of great importance; as upon its being well managed depends the permanent stability of the road. The old method was, after having spread the bottom of the excavation, or the top of the embankment, with a layer of ashes, small stones, or gravel, to place the blocks upon this, with the chairs and rails attached to them; workmen were then employed to push the ashes or sand underneath the blocks with narrow shovels, at the same time beating upon the upper side of the block with heavy mallets, till the rails were at the proper level. But in this manner no firmer seat or solidity to the foundation was

given than what was effected by the blows of the mallets upon the blocks, which having little effect in compressing or consolidating the foundation, when the carriages came to run upon the rails the blocks sunk down, and it required workmen to be constantly pushing ashes or sand underneath, to raise them to their proper level, until they came to a permanent seat; or, in fact, till the seats of the blocks became sufficiently firm to resist the weight of the carriages passing over them.

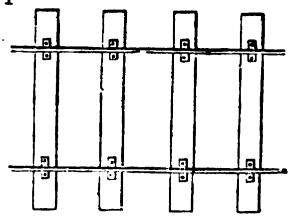
Mr. Nicholas Wood mentions, that when Mr. Stephenson was laying down the Liverpool and Manchester line, he adopted the plan of having the foundation in the first place so compressed and consolidated, that the weight of the carriages should have no effect in causing the blocks to yield. This was done by the impact of the blocks themselves; the principle being to employ a force or weight upon the foundation on which they had to rest that should be greater than the weight imposed by the action of the carriages on that foundation. To effect this he made use of the block itself, by successively lifting it up, and allowing it to fall upon the seat on which it was intended permanently to rest. The block was raised by every operation to such a height that, when let fall upon the foundation, the effect was much greater than the direct weight or pressure of the passing trains.

For the success of this plan it is essential that the material on which the coating is laid should be perfectly firm and solid; for the least subsiding or sinking of the foundation renders useless all this care for obtaining a firm position for the blocks. Hence, though the plan was found to succeed perfectly upon excavations well drained, or upon consolidated embankments, yet in clay, and other yielding soils, the whole expense of the setting the blocks was rendered unavailing by the yielding of the stratum below. Other means had accordingly to be resorted to, and in some cases the blocks were laid



diagonally, instead of vertically, as seen in the accompanying diagram, which was thought to have the effect of steadying the rails; while it gave to the workmen access to the four sides, to set them right if they became displaced. The difficulties, however, which attended the use of stone blocks at length led to the substitution of wooden sleepers, which have now almost altogether superseded them. The traveller on the London and Birmingham line may notice, at intervals, extensive piles of the blocks which have been

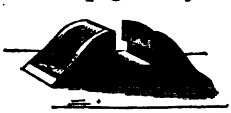
removed, any number of which may be purchased for about eighteen-pence each.



Wooden sleepers are now almost universally employed, and they serve at once as a support for the chair and rails, and as ties for keeping the line in gauge. The material first selected for this purpose was larch, which was split in two, and placed with the convex side downwards, this being considered the most durable wood for the purpose, next to oak. The plan has lately been adopted of using timber of larger size for sleepers, and which has been prepared by impregnating it with certain saline or other substances, by processes variously denominated, according to the principle and mode pursued. These sleepers have a greatly increased durability.

The distance between the sleepers depends upon the strength and weight of the rails. At first they were placed three feet asunder, which was afterwards augmented to three feet five inches, according to the strength of the rails; and at present they vary from one foot and a half to four feet apart. The size and strength of the sleepers have undergone similiar augmentation, according to the increased burdens imposed upon them.

The rails are secured to the sleepers by means of *chairs*, as they are termed. The chairs were formerly fixed to the stone blocks by wooden pegs; they are now held to the wooden sleepers by iron pins.

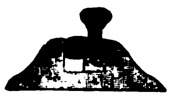


RAILWAY CHAIR.

The chairs are of cast iron, the size and shape of the cavity corresponding with the form and dimensions of the rail; and though depending for their exact shape on the opinion of the engineer, their usual appearance is very similar. The first rails on the London and Birmingham line required a considerable elevation of the chair, which involved the danger of its being wrung from the block—an effect which is found to follow in the exact proportion to the height of the chair. The block was also more loosened in the ground by a high chair, and the cost of the continual repair arising from this disturbance, amounted to one-half the wages expended in repairing the way in general.

When the rail is laid in the chair, it is usually secured in its position by means of a wooden *key*. A key is a small piece of thoroughly seasoned oak, which is forced into the cavity left between one side of the rail and one side of the chair. In order to give to the whole greater firmness, the key-wood is steamed, and then subjected to a

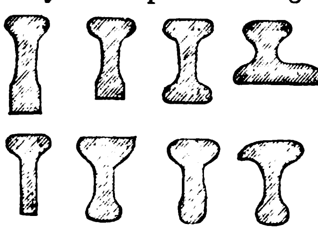
pressure equal to twelve pounds on the square inch, from a hydraulic machine. By these means its dimensions are considerably reduced; and the key being retained in a drying-house till required, it is easily forced into the chair when necessary, while the moisture of the atmosphere, and the weather, make it expand so as to hold the rail with great tenacity. So great has been the expansive power of keys, that they have, in a few instances, been known to burst asunder the iron chairs in which they were secured.



CHAIR, KEY, AND RAIL.

On the Midland Counties line, the wooden keys have been found not to last more than about five years; and as they cost from £8 to £10 per thousand,—and upwards of seven thousand are used in a mile of railway with double track and sleepers of three feet apart,—the expense of renewal becomes an important item. To provide something more permanent, Mr. W.H. Barlow has invented a kind of hollow or tubular key of wrought iron, which is made to press equally against the top of the chair, the middle of the rail, and its top and bottom flanches. It is said that these have been tried with success on the Midland Counties, South-Eastern, Warwick and Leamington, and some other railways.

The weight and the shape of the rails adopted are of great importance to the stability and economy of the line; and in the comparatively short period during which railways have been open, they have undergone great alterations. In determining the shape of the rail, it must be so formed that the pressure of the weight above may be as perpendicularly downwards as possible; for should it be directed sideways from the wheel, not only is there a great loss of power, but a strong tendency to throw the rails out of gauge, and thus endanger the safety of the trains.



SECTIONS OF RAILS.

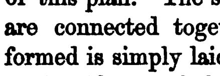
The great increase which has been made in the weight of the rails has naturally followed from the unforeseen augmentation of the weights which they have to bear. Thus the rails first employed on the Liverpool and Manchester line weighed only thirty-five pounds a yard; but these were soon found to be of inadequate strength. Accordingly, in the Report of the Directors in 1834, they stated, that in particular parts of the road, especially on the descending lines of the inclined planes, the rails proved too weak for the heavy engines, and the great speed at which they moved; and from the breakages that had taken place, the Directors had thought

it necessary to order a supply of heavier and stronger rails, which were to be substituted. And they subsequently stated that the re-laying of the way had produced perfectly satisfactory results. A portion of the line was laid with parallel rails, weighing sixty pounds to the yard, and not only were these more substantial, but there was a diminished charge for their maintenance. The great advance in the price of iron made this re-laying of the way a costly work; but it is only one illustration out of many in which the earlier lines, and especially the Liverpool and Manchester, had to obtain experience at a dear rate. Fortunately, the success of the earlier Companies provided them with the means of paying for these practical experiments without material injury.

Malleable rails have been found to be more durable than those of cast-iron, and are, at the same time, less susceptible of the deteriorating operation of the atmosphere, than the same rails would be if unused; for if a bar of wrought-iron be placed upon the ground alongside one of the same form and material in the railway in use, the former is continually throwing off scales of rust, while the latter remains almost wholly free from waste of this description—a fact which is believed to depend on certain electric influences communicated by the passage of the trains.

It may here be remarked, that at one time considerable difficulty was apprehended to the progress of trains during frosty weather, by the rails becoming glazed with ice. To obviate this evil the idea was seriously proposed, and protected by patent, in 1831, of making the rails hollow, and filling them with hot water during the winter!

On the Great Western Railway a peculiar plan is adopted of laying down the permanent rails. These are bridge-shaped, having



wide flanges or wings, and they are secured to continuous bearings of wood, instead of having the interrupted support of chairs and sleepers. The rails are regarded as necessary to guide the wheels rather than support them; and it is considered that less noise, greater steadiness of motion, and diminished wear and tear, result from the adoption of this plan. The sleepers are half timbers of American pine, and are connected together by transverse pieces. The framing thus formed is simply laid on the ballast, which is securely "battered in" at the sides; and the rails, of sixty pounds to the yard, are screwed down upon a piece of felt.

When the permanent way was first laid, the longitudinal sleepers were not only held together by the transverse beams, but these were kept in their position by a novel contrivance. Piles of great

length and magnitude were previously driven into the road, and the transverse timbers bolted to them at the centre. These were bound down to the road by the piles, while gravel, or other *packing*, was driven under the longitudinal beams supporting the rails, so as to prevent the transverse timbers from being broken or bent at the centre by the weight of the loads passing over them. In this way the piles were regarded as a constantly relieving power, holding the road down against the packing, which would otherwise force it up; so that the latter can be driven much harder in than by the ordinary mode. Mr. Brunel calculated that by these means he threw an upward pressure against the base of each longitudinal timber equal to one ton per foot forward, or about one ton per square foot. He thus obtained three tons for every three feet length of rail; while a stone block containing four cubic feet only weighs about a quarter of a ton, which is therefore the pressure with each three feet of rail laid in the usual way. The timber used in a mile of this kind of permanent way was about 420 loads of pine, and 40 loads of hard-wood; these required six tons of iron bolts, and 30,000 wooden screws. The rails laid thus were 44 pounds per yard; and the cost of the first portion, extending from London to Maidenhead, including laying, ballasting, sidings, driving, and all such work, amounted to £9200 per mile.

When the Great Western line, thus constructed, had been for some time in operation, it was found that the packing beneath the timbers required to be constantly renewed, and labourers had to be incessantly employed for that purpose. Experience soon proved that the system was ineffective; the piles, instead of affording a support to the road, prevented it from settling into its natural bed, and they were ultimately abandoned. The cross timbers were detached from the piles, and the railway consolidated upon the foundation of the road in the usual way, by the weights passing over it.

Mr. Brunel's plan of using longitudinal bearings has not been generally adopted. They were, however, laid down on part of the Hull and Selby line; but the result seems to be decidedly favourable to transverse sleepers. Mr. Gray, who was formerly locomotive superintendent on that line, says that great difficulty was found in maintaining the desired contact between the rails and the timbers; and if this were not preserved, water found its way into the crevices during wet weather, and was forced out with great violence by the passage of engines, each wheel throwing it against the opposite one. Mr. Gray states that he has seen an engine leave the dépôt "almost as clean as a new pin;" and in less than half an hour a clean spot could

scarcely be detected on it. It appears, also, that the *bite* of the wheels of the engines on the longitudinal timbers is not so great as on the cross sleepers; for, on making a trial one frosty morning, he found that the engine slipped so much on a level piece of ground that was laid with longitudinal timbers, that he feared the train would be unable to ascend an incline of sixteen feet a mile, which it was approaching; but, to his surprise and relief, he discovered, on reaching the incline, which was laid with cross sleepers, that the *bite* became good; and the engine "went up like an arrow." The slipping recommenced on reaching another portion of the road laid on longitudinal timbers, and again ceased on reaching the cross sleepers.

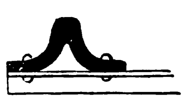
Before leaving the various questions involved in the construction and preservation of the permanent way, reference must be made to the recent employment of cast and wrought-iron bearings for the rails, instead of the ordinary transverse wooden sleepers.

The cast-iron road is the invention of Peter Barlow, Esq., C.E.; and has been laid down by him on the South Eastern Railway, to the extent of sixty-two miles. The advantages which have accrued from its adoption are increased firmness, security, and economy; and it appears to have been proved that there was not a greater amount of breakage than with ordinary cast-iron chairs, though the plan has been principally tried on a part of the line where the traffic is very heavy and the ballast defective. With reference to the statement which has been made, that there is increased vibration where the rails are supported on cast-iron sleepers, it seems that this is chiefly found where the road has been laid with old rails, as is the case on the Greenwich line; but on the Ashford and Hastings, and Tunbridge Wells and Hastings lines, where new rails were employed, we are assured that no difference of sensation can be detected. "There is no doubt," says Mr. Barlow, in a communication he has made to the writer on the subject, that "the road is hard and rigid; and this is what I consider *a road ought to be;* and if the surface is liable to unevenness or roughness, this should be corrected by wooden wheels and springs. But if you will ride over a long length on the South Eastern or Midland, you will agree with me that it is not disagreeable, or injurious, or noisy, and entirely different to the block road."

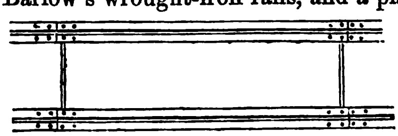
As an evidence of the advantages of the new method of laying the permanent way, the Midland Company report, that the nine miles which have been laid with cast-iron sleepers "continue to stand well, and are cheaper to maintain than the ordinary way;" while a statement of the Londonderry and Enniskillen Railway Company is

equally satisfactory. On the South Eastern line, the half-yearly account at the commencement of the present year states that the cost of maintenance on the 212 miles was £20,144 for the half-year, or at the rate of about £190 per mile per annum; while the writer has lying before him a copy of a letter from Mr. James Taylor, one of the contractors of the railway, addressed to the Directors of the South Eastern Company,* in which he offers to undertake the maintenance and renewal of the iron permanent way for a term of twenty-one years at £100 per mile per annum.

It appears, however, that the self-supporting, broad-flanged *wrought*-iron rails of Mr. W. H. Barlow have, on the whole, a greater aggregate of advantages than those of his brother. Difficulties have, until lately, existed in the rolling out of such heavy rails at the manufactories; but the improvement of machinery now allows of their being prepared with greater facility and at a less cost. It would appear that this method has decided superiority over any other; the wear and tear of the rolling-stock being greatly diminished, from the greater evenness of the joints; while it is found that provision against the effects of the contraction and expansion of a long length of rails riveted together need not be made, since in practice the



anticipated effects are not experienced. As the introduction of these new plans of forming the permanent way of our iron roads is producing quite a revolution in their construction, a section of Mr. W. H. Barlow's wrought-iron rails, and a plan of the method in which they



are laid, are given; and an estimate is also appended of the relative cost of construction and renewal of the several systems.

COST OF CONSTRUCTION.

Cross-sleeper road, including laying	£2602
Cast-iron road	2661
Wrought-iron road	2317

COST OF RENEWAL,

(The value of the materials of the old road being deducted.)

Cross-sleeper road	£1666
Cast-iron road	1296
Wrought-iron road	1267

The durability of the rails of the permanent way depends exclusively upon the work to which they are subjected. Dr. Lardner mentions

* Dated February 23, 1852.

that rails laid under different circumstances, and in various positions, on the Belgian railways, having been previously weighed with great accuracy, and being taken up after the lapse of a certain time, have again been weighed and the loss ascertained, and the quantity of work performed meanwhile been accurately recorded. The result of these observations has been, that, taking into account the wear and fracture, a line composed of well-manufactured rails, weighing fifty-five and a half pounds per yard,* and giving passage annually to three thousand trains, of fourteen coaches or wagons per train, will last a hundred and twenty years before it requires to be re-laid.

The rails from which these calculations were made were of English manufacture, and were taken from every variety of position which could be supposed to influence the rate of their wear; being selected from starting and stopping-places, from intermediate positions, and from ascending and descending gradients, in order that a correct average result might be obtained. It has also been ascertained, after elaborate investigation, founded on the theory of the action of the driving-wheels of engines, and the effects produced by the weight of the carriages, and also by the increased tractive power exacted from the engine, that in passing over about sixty English miles the engine abrades from the rails 2·2 pounds, each empty carriage or wagon four ounces and a half, and each ton of load about an ounce and a half. The relative returns thus obtained show that the wear is in exactly the ratio of the weight of the body that passes over.

Let these results be compared with those obtained on English lines. In April, 1849, the Directors of the London and North Western line received a Report, which they had ordered to be prepared, as to the probable duration of the permanent way, and the period at which it was likely to require to be renewed. In this document it was estimated that the actual average age attained by the then permanent way was seven years and a half, and that it might be reckoned to be capable of twelve years and a half more service, making a total of twenty years for its entire life-time. Now the average number of trains running over the principal sections of the London and North Western line is estimated at fifty, or 18,250 trains annually; which being continued for twenty years, we have 365,000 trains as the traffic necessary to wear out the line. The coincidence of the results of this estimate with that of the Belgian engineers, who, as we have seen, calculate 3000 trains per annum for 120 years, or 360,000 trains in the total, as the power of the duration of their lines, is very remarkable; and is the more

* Twenty-seven kilogrammes per current mètre.

worthy of note, as it appears that the Reports were drawn up without any reference to one another.

Though the weight of the rails on the Belgian lines is about fifty-five pounds, and on the North Western line from sixty to eighty, per yard, the conclusions given above will not be disturbed; inasmuch as the difference of the weight and the velocity of the trains on the two systems of railway are in equal proportion.

Assuming the rails commonly employed on our lines to weigh seventy pounds a yard, with twenty pounds for each of the chairs, and giving a sufficient allowance for the bolts, pins, and sidings, it is estimated that about 600 tons of iron are required for each mile of railway throughout the country. Now, as about 6700 miles are open for public traffic, it follows that more than 4,000,000 tons of iron are employed for this purpose. The net cost of a mile of the permanent way on the London and North Western line, with eighty-two pound rails, is about £2035, estimating the sleepers to last twelve years; or with sleepers to last twenty years, the sum of £2350 is required.

The enormous advance which was made in the price of iron during the early history of the railway system has very materially affected the outlay involved either in making or repairing the permanent way. The fortunes that have been made in consequence by many of the iron-masters have been immense; and hence it is not surprising that Lady Charlotte Guest should have piqued herself more on being the wife of the great iron-master than the daughter of the Scotch Earl. An amusing story is told of her ladyship, which so well illustrates the statement above made of the profits which accrued to those connected with the trade,—a result mainly attributable to the increased demands made by the establishment of the railways of our country, and the continent of Europe,—that we cannot refrain from quoting it. It seems that her ladyship was generally observed to be in a state of excitement about the time the balance-sheet of the works was being made up; and as soon as it was completed, so eager was she to see the amount of profits, that she had a copy despatched to her wherever she might be. On one occasion, she had a grand party at her London residence, and when the festivity was at its height, a courier arrived from Dowlais with a tin box containing the expected document. Lady Charlotte ordered it to be brought to her in the brilliantly-lighted saloon, where she was surrounded by a circle of her aristocratic friends and relatives, who probably occasionally, like her mother, enjoyed a sneer at the *cinder-hole*. "What's that, Lady Charlotte?" exclaimed they, all crowding round the

apparition of the tin-box. "'T is our balance-sheet," answered her ladyship. "Balance-sheet!" exclaimed the fair aristocrats; "what's a balance-sheet?" "It is an account made up, and showing the profit down at the works for the last twelve months." The company laughed, for they thought with Lady Lindsay of the *cinder-hole;* but the Welsh iron-master's wife bided her time, for she knew the laugh would be with her as she opened the tin case, and drew out the document. "And so that's a balance-sheet," exclaimed her friends, crowding round the paper with the double entries and the red lines, and they looked on it as on a phenomenon—they had never seen one before; and if they had heard of one, they thought it was something belonging to a ship. "But what are the profits?" cried they, as Lady Charlotte scanned her eye over the paper. Lady Charlotte not seeming to heed them, said as though she spoke to herself, "Three hundred thousand pounds—a very fair year," and she re-committed the balance-sheet to its tin case, while peeresses looked as Lot's wife might have done as she was being changed into salt. "Three hundred thousand pounds profit! What! you don't mean that in one year?" "In one year," was the reply, as if there was nothing at all remarkable in the matter. "I'd be a Cinderella myself," said a Border Countess, "to a husband with such a business. Three hundred thousand pounds, only think! and all from that nasty cold iron—it beats the glass slipper!"* But from this digression we must return.

The maintenance of the permanent way in perfect efficiency is of the utmost importance. To provide for this, the line is divided into sections, each of about a score of miles, to which "overlookers" are appointed. These sections are subdivided into short lengths, superintended by a foreman, or "a squinter," as he is technically designated, with two or three assistants. The duty of the foreman is to visit his portion of line every morning before the first train passes, to see that the rails and sleepers are perfectly secure, to observe whether the keys are fitted in the chairs, and generally to inspect the fences and works. In case of repair being required, he summons his men to the spot, and if it is sufficient to interfere with the passage of trains, or to warrant the exercise of special caution on the part of engine-drivers, a signal flag to that effect is placed eight hundred yards above the injured spot, until the "patch" is completed. If one party is not sufficient to perform the labour within a reasonable period, assistance is summoned from other parties of men up and down the line, in the proportion desired.

* Roebuck's "History of the Whigs."

During the progress of the relaying or repair of lines to any considerable extent, it is of vital importance that complete arrangements should be made for the continuance of the work with the least possible interference with the running of the trains. As an illustration of the instructions which are given to engine-drivers and to workmen during the progress of such alterations, we append a copy of one of the documents issued on a recent occasion on the London and North Western line, during some repairs between Willesden and Harrow stations, "from the six and a half to the nine and a half mile-posts," which were carried on at the undermentioned times:—

FROM 4.30 A.M. TO 6.10 A.M.,

That is, after the passing of the 3.45 a.m. Goods from Camden, until the 6.0 a.m. Newspaper Express Train from London becomes due. Again—

FROM 6.20 A.M. TO 6.40 A.M.,

That is, after the passing of the 6.0 a.m. Newspaper Express Train from London, until the 6.30 a.m. Passenger Train from London becomes due. Again—

FROM 6.55 A.M. TO 7.15 A.M.,

That is, after the passing of the 6.30 a.m. Passenger Train from London, until the 7.0 a.m. Third Class Train from London becomes due. Again—

FROM 8.0 A.M. TO 9.20 A.M.,

That is, after the passing of the 7.30 a.m. Passenger Train from London, and a Pilot Engine to Watford, until the 9.15 a.m. Express Passenger Train from London becomes due. Again—

FROM 10.20 A.M. TO 10.40 A.M.,

That is, after the passing of the Day Mail Train from London, until the 10.30 a.m. Passenger Train from London becomes due, Again—

FROM 12.20 NOON TO 12.40 NOON,

That is, after the passing of the 12.0 noon Passenger Train from London, until the 12.30 noon Goods Train from Camden becomes due. Again—

FROM 1.0 P.M. TO 1.25 P.M.,

That is, after the passing of the 12.30 noon Goods Train from Camden, until the 1.15 p.m. Goods Train from Camden becomes due. Again—

FROM 3.10 P.M. TO 3.35 P.M.,

That is, after the passing of the 2.45 p.m. Passenger Train from

London until the 3.30 p.m. Passenger Train from London becomes due. Again—

FROM 4.15 P.M. TO 5.0 P.M.,

That is, after the passing of the 4.0 p.m. Passenger Train from London until the 5.0 p.m. Express Passenger Train from London becomes due, when the Relaying is to cease for the day.

Although all the Down Trains will travel on their own Line, they must do so at cautious speed over the newly laid portion, and should any Train arrive out of course during the hours the Plate-layers are engaged, they are not to proceed forward on their journey until advised by the Policemen engaged with the workmen that the Line is ready for their passage.

Until the work is reported complete, the Drivers, Guards, and Breaksmen of all Down Passenger and Goods Trains are to be instructed by the Foremen on duty, before leaving Euston and Camden, that they are to be in readiness to stop on the instant the Policeman engaged with the Working Party signal them to do so.

A Policeman is to be specially appointed to attend the Working Party, and stop any Train, should it be necessary.

H. P. BRUYERES.

SUPERINTENDENT'S OFFICE,
EUSTON STATION, 30*th March*, 1852.

That systematic precautions should be adopted for the preservation both of train and of workmen, is obvious from the fact, that in several cases serious accidents have been occasioned to those employed, and passengers have been exposed to great peril, in consequence of these precautions having been neglected. Instances have occurred like the following, which will speak for itself of the importance of taking the utmost care when repairs have to be effected on the main line. A broad vale in our midland district is crossed by an embankment which supports one of our Iron Roads. A score of plate-layers have been sent to repair part of the line, and are busily engaged in their task. The watchman appointed to the gang is not so attentively on the *qui vive* as his duty requires, for he is chatting carelessly with an acquaintance, who has strolled across the line. In the far distance a white mass of steam rises in the air among the trees, and is anon blown aside as the breeze sweeps by; and at length the deep hum of the iron tread of the approaching train falls upon the ear. But the attention of the signal-man is still absorbed in his conversation, and the men in their work; while the clink of the heavy

hammers on the metals, and the orders of the superintendent, drown the sound of the train. Suddenly the character of the noise is changed, and the signal-man sees the danger which his neglect has incurred. He shouts to his companions, who have a lorry laden with wood and rails, on the very line on which the train is coming; and he also stretches out his red flag that the engine-man, though late, may see it. But the pleasant murmur of the train has become a deep intermitting boom, and the mass rolls over the rails with a sound like thunder. Meanwhile the workmen are not idle. Several timbers and metals have been flung off the miniature wagon, and with almost frantic efforts and superhuman strength the men strive to clear the line before the train is upon them. That shrill unearthly scream from the engine, which pierces their ears, and scarcely less alarms the passengers, can hardly hasten them. The guards and stoker have applied their breaks, and the driver stays his engine, and then reverses its machinery, and exerts his utmost force, though in vain, to stop the motion. The whole mass fairly glides upon the rails with the momentum of some sixty or seventy tons; and then comes the moment of suspense, when nothing can be done by the train to save itself, and it must wait its destiny. But just as almost the last instant has come, the obstacle is removed; the half-dozen sturdy men have hurled the reluctant lorry off the rails, and down the side of the embankment; and the huge mass of the train glides by in security, though with not many seconds to spare. The breaks are released, the engine is reversed, the steam is turned on, and leaving the offending signal-man to the punishment of his neglect—for which he will have to answer before the nearest magistrate—the train rolls forward with its wonted speed, until smoothly and silently it comes alongside the platform of its next stopping-place.

CHAPTER X.

Visit to the Euston Terminus—The Station—The Great Hall—Parcels Delivery Office —Lost Luggage Department—"A Curiosity Shop"—The Down Train—The Platform—First, Second, and Third-Class Passengers, their Races and Habits—The Camden Station—Passenger and Goods Engine Dépôt—Cattle Platform—Goods Department—The Up Train—The Ticket Platform—Refined Discrimination—Arrangements for the Up Train—The Up Platform—The Arrival—King's Cross Station—Intermediate Stations—Chester Station—Scenes at an "Intermediate"—Buildings and Arrangements—Waiting for the Train—The Approaching Train—Processes on the Arrival of the Train—The Deserted Station—The "Arrivals"—Crossings—Sidings—Chocks—Station, Auxiliary, and Junction Signals—Time Signals—Electric Telegraph Signals—A Novel Contrivance for Signaling, and its Results—Fog Signals—An Amusing Experiment—Carriage Department—Carriage Cleaning—Refreshment Establishments—Wolverton—Practical Economy at Tonbridge Station—Swindon—Optical Illusion—Vehicular Establishments at Intermediate Stations—A Cross Country Journey—Scenes by Night at a Station—Battle Station—Woburn Station—Level Crossing Stations—The *Personnel* of a Railway—The London Railway Clerk—Duties of the Clerk—Policemen—Official Propriety—Porters—Guards—Duties of Guards—Incident—Duties of Engine-Drivers and Firemen—Unique Position of the Drivers—Wages of Drivers and Firemen—The Station Mercuries—Anecdotes.

HERE you are, Sir! is the somewhat self-contradictory exclamation of the sturdy, but officious cabman, who anticipates the wish of an approaching pedestrian to avail himself of the advantages of "the stand." Philosophic minds have attempted to discover the means by which the cabmen of the modern Babylon are enabled to distinguish with preternatural accuracy between "fares" and the common run of travellers; but the only conclusion appears to be that that unique race of Jehus are gifted with a capacity of intuitive perception, or an intentional consciousness, as the Germans have it, denied to other mortals. Without detaining the reader with any metaphysical analysis of the arguments advanced in the support of so momentous a conclusion, or pointing out any of the principles which might be legitimately deduced from such premises, it will be sufficient to request him to seat himself in the vehicle, and to pay a visit to the Euston and Camden stations of the London and

North Western Railway. "Nimble as a bee," the driver snatches away the piece of sacking that is supposed to retain the caloric in the loins of his horse, and instantly goes through a series of evolutions in order to bring his cab alongside the kerb-stone, which could not be adequately described without the aid of diagrams, and which the uninitiated observer would probably conclude was for the purpose of driving the horse in at the open door of the vehicle instead of putting the passenger there. In a few moments, the traveller is rattling over the stones in the desired direction.

The cab enters the Euston station under the propyleum, which has been erected after a Grecian model, and has Doric columns of the largest size constructed in modern times. The outer vestibule of the great hall, at which the vehicle pulls up, has a beautifully designed mosaic pavement, constructed of patent metallic lava within a border of Craigleith stone, and from it the vestibule is entered. This is more than 125 feet in length, and sixty in width and height, and, as respects both size and grandeur, is, it is believed, unsurpassed. At the northern end is a noble flight of steps leading to another vestibule, in which are doors conducting to the general meeting-room, and the board and conference-rooms, while a variety of galleries and staircases communicate with numerous offices.

The buildings are in the Roman-Ionic style of architecture. The ceiling of the vestibule is divided into panels deeply coffered, and is lighted by windows above the entablature. There are pillars at the head of the stairs, painted in imitation of dark-red granite, which have a very handsome appearance. The hall is warmed by hot-water pipes, due regard being paid to ventilation. Eight bas-reliefs adorn the columns in the corners of the halls, having symbolic representations of the characteristics of the cities and towns of London, Liverpool, Manchester, Birmingham, Carlisle, Chester, Lancaster, and Northampton, through which the line passes.

Several departments of the Company's operations are carried on at the Euston station, which are well deserving minute observation; but a brief allusion must here suffice. One of these is the Parcels Delivery Office, whence an immense quantity of small packages of all shapes and sorts are hourly issued, while an equal number are received, classified, booked, and despatched to all parts of the middle and north of England.

The Lost Luggage Office is a scene of interest. When a train arrives at the termination of its journey, every carriage is scrupulously examined by a *searcher*, and anything which may be found is conveyed to this office. The description of the article, the day of

the discovery, the train, and the carriage, are noted down by the superintendent of this department with the greatest accuracy; and if anything be discovered that bears an address, if not applied for within twenty-four hours, it is forwarded to the owner. If it has no address, and is not inquired for at the end of a month, it is opened, and if it give any intimation of the owner, communication is made with him. If no intelligence can be obtained, it is disposed of by auction, after the lapse of two years from the date of its discovery. In this department is kept a luggage inquiry-book, in which a description of articles is entered which passengers have lost in travelling, and inquiry is then made for them at the Lost Luggage dépôts. All articles found between London and Wolverton are forwarded to the metropolis, and those between Wolverton and Birmingham are sent to Birmingham. If other resources fail, the superintendent of the office writes to more than three hundred stations, with which this office is connected, to inquire after the missing goods; and in the event of this effort being unsuccessful, the seeker receives a final communication on the subject. The collection of articles in the Lost Luggage dépôt is atonishing: innumerable shawls, cloaks, umbrellas, parasols, reticules, scarfs, boxes, bags, eatables and drinkables, may here be seen; while the variety has been amusingly increased by the presence of a pair of leather hunting-breeches, a boot-jack, a knapsack, a regimental coat, a Scotchman's bagpipes, and a pair of crutches.

Passing from the offices of the station to the "down platform," a train is about to start, and we may linger a few moments to witness the interesting spectacle. The sun's warm rays gleam from above, and show the web of interlaced rods, bars, and bolts, that support the immense area of plate-glass which forms the roof. On the dozen pairs of rails that divide the up from the down platforms are strings of carriages, some of which have been collected into the train which we now behold. Porters bustle about with luggage of all kinds and shapes on their shoulders, or they trundle little mountains of baggage to the vans in wicker-work trucks, which have the appearance of something between a clothes-basket and a badly-constructed cradle. One man endangers the heads of the public generally by the clumsy manner in which he conveys a huge box towards the luggage van; while another, who is propelling a heavily-laden truck, seems to feel perfectly justified in knocking any one down or bruising their shins if he has first sought their permission by muttering the mythic and mystic words, "By y'leave."

The train is now rapidly filling, and the luggage is deposited in, on, or under, the several carriages in which the passengers travel, or

is put into the break. While these arrangements are progressing, we may take a momentary glance at the passengers.

There is a first-class carriage with its characteristic assortment of inmates. The middle seats are occupied by two stout gentlemen, one of whom is nearly hidden behind a copy of a morning paper he is reading, while the other is almost, and will soon be entirely, asleep, having already stowed his head in a cap which comes down nearly to his nose. Their travelling companions are a young member of an old family in the north, a lady and her daughter. The "sprig" will soon find, most unaccountably, that the view from the window on the other side is far more attractive than that on his own, and will consequently prefer to direct his attention that way; and the young lady might doubtless be considered to be reading the novel which she has just purchased at the book-stand, were it not that she will not turn over a leaf above once in half an hour.

The second-class passengers are another genus. One, who is a commercial traveller, puts on a red cap while the train is alongside the platform, and will be nearly asleep before it is out of the yard, for he is an old stager, and economises his strength. The people here are more communicative, and are sometimes even facetious. The chances are that they will joke about the engine, say that they prefer having their backs to the horses, talk about a "feed of coke," or when the engine whistles they will exclaim pathetically "Poor creature!" These puns, mild as they are, are laughed at by the good-tempered passengers as if they had never been heard before, instead of it being the five-hundredth or the five-thousandth time. Others of the travellers, having a turn of mind for the agreeably tragic, will point out on the journey the precise spots where certain dreadful accidents happened, with the idea, it is presumed, that such recitals give a pleasant piquancy to a journey. The terrible disaster of the mail train, which left York for London on the night of the 30th of February last, and has never since been heard of, will be listened to with appropriate feelings of pity for the unfortunate sufferers! These allusions, of course, produce a very gratifying effect on the mind of "the old lady," who is always to be found in one of the second-class carriages of every train. We particularise her, because she is invariably there. She is first found in great distress about her box, which is a thing perfectly unique; and which she is afraid may be pocketed by some one, (though it weighs a good half-hundred-weight), in its passage from the omnibus to the platform, while she is obtaining her ticket. Then it is a source of the deepest anxiety to her because it cannot be put under the seat,

and will not go into the locker of the carriage in which she is to travel, and it is finally put in a remote van, where the old lady would like to go too. Her ideas of steam-power are peculiar, for she looks upon the engine as something between clock-work and gunpowder, and as altogether a very dangerous thing to play with. The engine, she also imagines, has an innate and inveterate propensity to run away by itself, and to rush from the rails in the middle of the highest embankments on the line, for mere purposes of self-destruction.

In reference to the second-class passengers, it may be safely predicated of them, that there is one topic on which they are all agreed, and on which they will not fail to expatiate until their journey's end. It refers to the strong sensation they have of sitting on uncommonly hard seats. Indeed, the theory has been fully discussed, and is popularly regarded as in the highest degree plausible, that the Directors of railways send deputations of skilled carpenters all over the world to obtain the hardest wood which can be found, with which to make second-class seats. The result of their investigations has been most satisfactory to the Companies; the only difficulty arising from a vague misgiving that perhaps the "seconds" may flee to the third class, which cannot be worse.

We cannot on this line point out the characteristics of the passengers who travel—as in the Midland districts—in that unique species of conveyance, the open third-class carriage. But it is worthy of remark, that these vehicles have the peculiar and interesting property,—of always meeting the rain from whatever quarter it may come. On those occasions the carriages are a species of horizontal shower-bath, from whose searching power there is no escape. It has been well remarked, that a wet, steaming, dripping coach, was a melancholy object enough, swaying through a village with its compact hood of umbrellas, looking for all the world like a large green tortoise lying over the top; but it was nothing to one of these open cars in wet weather. To escape the rain is simply an impossibility. If the traveller turns his back to it, he finds the nape of his neck filled with water; if he faces it, his pockets are turned into wells; if he thinks to protect his hat by his handkerchief, it only augments and prolongs his misery, for the rims become like brown paper, and he is then in a difficulty to know where to put the dab of a handkerchief. It is a fortunate circumstance, that even third-class passengers can have covered carriages once every day on all the lines in the country.

But the train is about to start. The "five minutes" bell has rung;

places are occupied; friends prepare for their final adieus; and the last passengers and packages are hastily deposited in the train. Meanwhile, the guards have assumed their stations at the beginning and end of the train, and—if it be a long one—at the middle; and when all is ready, each of them waves a white flag. The station-master, whose duty it is to see all the trains off from his station, glances his eye along to see that all the passengers are accommodated, and the luggage deposited; observes the "all-right" signal of the guards, and then waves his flag to the engine-driver, who has been watching, with his hand upon the "governor," for the required authority. Instantly the whistle shrieks, and the train is in motion. The last "good-byes" of separating friends are hastily exchanged; the loud "chay! chay!" of the steam, which is at first heard at perceptible intervals, soon becomes a continuous sound; and passing along a cutting in the London clay, the walls of which are supported by massive iron beams stretching across the line, and through two short tunnels, the train reaches the Camden station.

The metropolitan terminus of the London and Birmingham Railway was originally situated at Camden Town; and thirty acres of ground were purchased, a quantity considered by many as preposterously large. Experience soon showed that a station nearer London was indispensable to the complete success of the line; and fourteen acres, which till 1825 had been the quiet scene of nursery-gardens, were obtained and formed into the Euston station. On its being opened, the whole of the Camden station was laid out as a locomotive, goods, and cattle station; and though in the original designs great care had been taken to anticipate the requirements of an augmented traffic, yet such was the rapid development of the railway system, that in the space of ten years it was found necessary to sweep away almost every vestige of the original buildings, and to remodel the whole. This arduous undertaking has been progressing for some years, and is not yet completed; for the varying contingencies of the traffic demand, that while provision is made for all necessary requirements, no unwarranted outlay should be hazarded. The works which have been erected are, however, highly characteristic of the advance of mechanical science, and well deserving of special allusion.

As the visitor looks towards the north, the dépôt for passenger engines is on the left hand, and that, till lately, employed for the goods, is on the right. The first "stable" is 400 feet in length, by 90 in breadth, and generally contains from 30 to 50 locomotives; while the adjoining coke-sheds are capable of containing 1500 tons of fuel.

The Goods engine Rotunda is an immense building, 160 feet in diameter, and is capable of containing twenty-four engines of the largest size; but since the opening of the Dock Junction Railway, it has been exclusively devoted to the engines used on that line. In the centre is a turn-table, forty feet in diameter, by means of which a driver and fire-man can turn their engine so as to face the opening, or may deposit it in any of the twenty-four stalls which radiate on all sides.

In locomotive dépôts various interesting operations may be observed. The water is perhaps being discharged from "the biler" of a locomotive, as the "fitter" calls it, and it gushes forth from the side-cocks with great impetuosity: or the furnace of an engine is just about to be lighted up, an operation which is commenced by depositing a few huge shovels full of red-hot coals from a fire kept for the purpose; while a "fitter," in a mass of soiled fustian, clambers around, and listlessly rubs the gleaming metal with a handful of oily rags, or inserts long-handled oil cans, with still longer spouts, in various parts of the machinery. Another is engaged in cleaning the tubes of an engine by means of a long and flexible iron rod; and perhaps a "coadjutor"—to employ modern phraseology—is standing upon the boiler, and "rubbing down" the funnel.

Near this building is the platform for landing the cattle and sheep which arrive here for the London markets; and the spot, at particular seasons of the year, is almost covered with them. Separating this part from the remainder of the station, is the terminus of the Dock Junction line, and also the Camden passenger-station of the North Western Railway.

The entire arrangements at this station, for conducting the goods department of the Company, are on a colossal scale; and this will not be surprising when it is stated that the merchandise received from up and for down trains, averages between eight and nine hundred tons a day. During the six months ending the 26th of August, 1848, 73,782 railway-wagon loads of goods entered and departed from Camden station; while, as a remarkable illustration of the development of the latent resources of a great country by cheapening traffic, the carriage performed by the Grand Junction Canal, which meanders alongside its powerful antagonist, has actually increased to a very considerable extent since the opening of the London and Birmingham Railway. As soon as goods trains emerge from Primrose-hill Tunnel, they exchange the main line for some side-rails employed exclusively by them, and advance into the station towards the goods department. This is under the agency

of Messrs. Pickford, and Messrs. Chaplin and Horne, whose experience enables them to arrange the details of this immense and intricate business with admirable completeness and success.

The goods dépôt was erected by Mr. L. Cubitt, with express reference to the demands of railway traffic. The extent of the area of the principal warehouse will be understood when it is stated to be twice that of Westminster Hall, being about 230 feet long, by 140 in width. The roof, divided into three sections, and supported by two rows of pillars, has nearly an acre of slating, and 100 skylights. The whole is erected on vaults, and out of the 3,000,000 of bricks employed in the building, a large proportion was expended in their construction. In Messrs. Pickford's receiving-shed there are 24 steam-cranes and 21 wooden ones, besides a steam-lift, a travelling-crane on the roof, and a steam-capstan for hauling trucks along the rails. To prepare food and water for the 222 horses employed by this department, there are four steam hay-cutters, which prepare fifty trusses of hay an hour; and an engine of 16-horse power, which besides driving the hay machinery raises water from an Artesian well, 380 feet deep.

On goods being forwarded to any of the receiving-offices in the metropolis, they are conveyed to the Camden station by the wagons of the Company, and after midnight they often continue to arrive. Empty trucks having been brought alongside the platforms, they are loaded; care being taken to pass them under a gauge, which is less than the height of the arches and tunnels through which they will have to pass. A canvass sheet is then stretched over the load, and secured with cords, to protect its contents from the weather; a printed ticket is affixed, with the name of the town to which each wagon is assigned; and the train is marshalled in the order most convenient for leaving the different trucks which are destined for particular stations on the line. So complete are the arrangements of the Company, that fifty wagon-loads of merchandise have frequently been despatched from hence to the manufacturing districts within two hours.

When an up train arrives, the operations just described are reversed. The various packages are transferred by means of cranes to the warehouse, their weight is entered, and they are classified so that they may be removed to the various London districts. An enormous accumulation of valuable merchandise, apparently in the utmost confusion, is thus seen, when, in fact, it is arranged in complete order. Meanwhile, the horses are prepared to remove the loads, and they may soon be observed proceeding with them in various directions.

Some idea of the extent of the Camden station, and the magnitude of all its business arrangements, may be gained when it is mentioned that the length of the single line of railway, exclusive of the main lines, is more than twelve miles. The annual consumption of gas exceeds six millions of cubic feet. Here, too, trains proceeding up and down may be observed at all times of the day and night wending their rapid course from and to distant localities; and, indeed, there does not appear to be any spot in the country which is better calculated to impress the mind with the magnitude of the requirements of a large and efficient railroad than this. Nor is this surprising, when it is remembered that this is the chief metropolitan terminus of a railway which includes 438 miles open to public traffic, and on which £18,000,000 have been expended; while it is interested, by subscription, contribution, or guarantee, in a number of lines which, with those already finished or in course of construction, form an aggregate of 641 miles, on which more than £25,000,000 sterling will ultimately form the outlay.

But our observations are interrupted by that bell which just smote upon the ear, and which declares that a train is arriving from the north. It is, in fact, in Primrose-hill Tunnel, and if the visitor passes to the ticket-platform at the southern end of the station, he may be initiated into the rites and ceremonies attendant on the reception of an up train. As soon as the bell is sounded, one of the Company's servants at the Camden station, who has charge of a hydraulic machine for condensing air, allows a portion to rush through an iron tube, and thus gives a loud intimation of the arrival of the train to a policeman on the up platform of Euston station. As soon as the well-known sound is heard, he emerges from his little "local habitation," and touches the trigger of a bell outside the door, which announces the event all over the station.

Scarcely have these duties been discharged, than the train makes its appearance at the northern end of Camden station, and giving all sorts of shrieking signals to the functionaries there, soon reaches the ticket-platform. Two inspectors are here in attendance to receive the "cards authoritative," and it is affirmed that these officers exercise a very refined discrimination in the fulfilment of this commission. "Tickets, if you please, ladies and gentlemen!" are the euphonious accents which fall on the ear of the first-class passenger. This is modified, it is said, to the—"Tickets, gentlemen, tickets!" of the second-class; while the appeal is shaded off into the—"Where's your tickets?" of the third. How much of truth there

may be in this assertion must be left to the experience of travellers; for ourselves, we confess to have been uniformly treated with every attention by the various and numerous functionaries of this railway.

While the progress of ticket-taking is thus proceeding, the engine is detached from the train; it advances a short distance, and being turned by a policeman into a siding, it runs back so as to be ready to push the carriages to the top of the incline which leads down to Euston. It is worthy of remark, that passengers who wish to go City-ward may alight at this platform, and proceed from thence by the Dock Junction line.

By this time the passengers have fumbled in half their pockets for their tickets, delivered them to the authorities, and have collected the various minor articles of luggage, such as coats, cloaks, parcels, bags, travelling-caps, baskets, umbrellas, and newspapers, which accompany them in the carriages. The Euston station-master having in the interim definitely ascertained that the line is clear, announces this, by means of his compressed air apparatus, to the ticket inspectors at the Camden platform, who are on no account allowed to let a train depart till they have received this intelligence. The train will proceed the remainder of the journey by its own gravity, the inclination of the line from hence to Euston being considerable. Many of the travellers, however, are unaware of the circumstances in which they are placed, and the apprehension of some would doubtless be great, were they the casual observers of their position. Could they stand on the railway and see the long line of carriages advancing by themselves, apparently without any power to control, or any agency to guide their movements, it would seem that nothing could stay their onward progress to utter destruction. But the guards, or "bank-riders," as they are called, who (a superficial observer might imagine) were only looking to see when the collision would take place, have command of the whole; and by means of the breaks, the levers of which they hold in their hands, they regulate the speed so as to conduct the train with perfect safety to its destination.

At length the people on the arrival-platform see the train emerge from under the bridge, the porters prepare for active work, the cab-horses prick up their ears, and with a jolting from the turntables, which are crossed, the train is quickly alongside. The guards apply the breaks, the doors of the carriages are opened, and forthwith emerges a mass of human beings, who seem to have predetermined to create on their arrival the greatest possible amount of confusion in the smallest possible space of time. The recognitions of

friends are scarcely exchanged, when some or all rush off in quest of the horse-hair trunks, carpet-bags, boxes, portmanteaus, and hat-cases, which are included in the all-comprehensive generic term of luggage, and they at length re-unite, bringing with them, or on the broad shoulders of sturdy corduroy-clad porters, the identical packages which were deposited in the van at Glasgow, Perth, or Liverpool. A vehicle is now obtained, and by the assistance of carriage, omnibus, or cab, the party is soon "clear off the premises." As the cabman trots past the departure-gate of the station, he communicates the place of his destination to a person there appointed to receive and record it; by means of which, if travellers leave property in the vehicle, they can be discovered—while if they are escaping the clutches of the law, a clue is furnished for their apprehension.

The Euston and Camden stations of the London and North Western Railway unite to form the metropolitan terminus connected with the largest and most influential system of lines in the country. But when the terminus of the Great Northern Railway at King's Cross is finished, it will be the most compact, extensive, and complete in the world. The magnificent sheds for the arrival and departure departments, the arrangements for the coal, corn, and other goods business, have been provided on those principles which the results of the experience of other railways, in the lapse of years, have established. Provision has also been made for the contingencies which may arise in the future development of the requirements and resources of each department of the terminus.

The attention of our reader is now invited to those characteristics of structure and management which are found less at the termini than at the intermediate stations of our railways. Some of these, especially where several important lines happen to unite, are very complete establishments; while in the least remarkable of them it is necessary that provision should be made for the carrying on of duties which will form an interesting subject of examination.

One of the largest of these stations, which may be regarded in one sense as intermediate, and in another as terminal, is that of Chester. It consists of a noble pile of buildings in the Italian style, the façade fronting the city being 1050 feet long. The centre of the station, which is two stories in height, contains on the ground-floor the usual offices for passengers; and in the upper part are those required for the management of the business of the Companies whose lines here unite. These apartments are more than fifty in number. The wings are formed of projecting arcades, with iron roofs, and are appropriated to private and public vehicles waiting the arrival of

trains. On the inner-side of the office-buildings is a large platform 750 feet long, by 20 wide, and chiefly used for departure trains. It is covered, as are three lines of rails, by an iron roof of sixty feet span, which is one of the most elegant yet constructed; and, as the height of the walls on which it rests is twenty-four feet from the platform, the entire structure has an imposing appearance. Behind this shed, and only divided from it by a series of pillars and arches, is a space for spare carriages, 450 feet long by 52 in width, which is also covered by a beautifully constructed iron roof. There are likewise two sheds for arrival trains.

All these departments are abundantly lighted from above during the day, and by gas at night, which is manufactured, expressly for the purpose, close at hand. Connected with the gas-works there is a spacious reservoir, from which an engine pumps water into a tank at the rate of 400 gallons a minute, the tank being placed so high as to command all the upper floors of the station. Extensive and complete arrangements are also made for the goods traffic.

An intermediate station of any importance on a main line is always a place worth visiting, to one at all interested in railways. It is pleasant to watch the different trains come sweeping up to the platform, or rushing through the station with a *rrh-oar* and a *whish* that makes the ground tremble beneath their iron tread.

"First, the shrill whistle, then the distant roar,
The ascending cloud of steam, the gleaming brass,
The mighty moving arm; and on amain
The mass comes thundering like an avalanche o'er
The quaking earth; a thousand faces pass—
A moment, and are gone, like whirlwind sprites,
Scarce seen; so much the roaring speed benights
All sense and recognition for a while;
A little space, a minute, and a mile.
Then look again, how swift it journeys on;
Away, away, along the horizon
Like drifted cloud, to its determined place;
Power, speed, and distance, melting into space."

Now come long luggage-trains, pursuing their heavy way with a business-like stolidity of demeanour perfectly compatible with their great weight and respectability; and then short, dapper trains emerge from the same out-of-the-way part of the establishment, which take a spurt up or down the line, as if to try their wind and limbs. Occasionally a mysterious-looking engine will make its appearance, squeaking, hissing, and roaring—now enveloping itself in a cloud of steam, and then rattling away as if ashamed of itself;

now advancing a few yards as if pawing the ground, and wanting to start somewhere in great haste; now backing again under the curbing hand of the driver, who restrains its hot breath and life; and then, with a succession of curious jumps and pantings, running backwards down the course, or turning into a siding, evidently with something very distressing upon its mind, and at last finishing its evolutions by spluttering, and dashing out of sight, as if in search of something which it had dropped on the road, or madly intent upon suicide.

When an ordinary observer first looks at all these manœuvrings at an "intermediate," instead of feeling surprise at the number of railway accidents which occur, he comes to the conclusion that the only wonder that a sensible man can have is, that there is anything but accidents from morning to night; but afterwards, when he has examined thoroughly into the arrangements—ascertained when, and how, and why they are adopted—discovered the interpretation of those mystic wavings of red, and green, and white signals, and the workings of the arms of the signal-posts—he sees that everything is so admirably managed, that it is only by the occurrence of something very unexpected, or a strange complication of inadvertencies, that he can conceive of any misfortune happening.

The extent of the buildings of an intermediate station materially depends upon the amount and nature of the traffic of the place or of the line. As many fast trains will go through without stopping here, the main rails must be kept constantly clear; sidings must be provided to receive slow trains; the goods arrangements must allow of trucks and wagons being taken from the main line to the goods department, or *vice versâ*, with as little interruption and risk as possible; and the establishment throughout must be so maintained as to furnish adequate accommodation, both of things and men, not only for the general business of the station, but for the particular moments of excitement and bustle connected with the arrival or departure of the trains. As part of the work must also be carried on by night as well as by day, a division of labour has to be made, so as to distribute the burden of duty as equally and as lightly as possible, consistent with the efficient working of the whole.

But some travellers are now dropping in, and, having obtained their tickets, they stroll on to the platform, for the down-train from London will be here directly. Glance round at the group. There is an old lady, with a band-box slung on her arm by an ancient-looking silk handkerchief of gaudy colours. A porter is wheeling her luggage to the point where the break-van will stand when the

train arrives; and, seated on a hamper, is her grandson, a chubby-faced baby, who stares fixedly at everybody and everything, and who kicks his approbation of the scene, so far as the marvellous swaddling of shawls in which he is enveloped will admit. There is also a stout, business-looking, middle-aged gentleman, who has driven up with a well-bred horse. He is the squire of a neighbouring village, a rural potentate, who is going to a large town, where, instead of being regarded with reverence and awe, he will sink down to the ordinary level of our common humanity. Half-a-dozen others of the gentry of the neighbourhood, a few trades-people, a papa and his three boys (whom he is taking to school), a governess going home for a holiday, and some farmers and cattle-jobbers, complete the picture.

But the train is in sight. It has just passed the curve, and in the extreme distance a white line of cloud appears to rise from the ground, and gradually passes away into the atmosphere. Soon a light murmur falls upon the ear, and the polished metal of the engine glances in the sunlight. The murmur becomes deeper and louder; the cloud rises to a more fleecy whiteness, or, as it is tossed aside by the wind, it reveals part of the dark, serpent-like body of the train. On it rushes, now showing its flank as it threads its way round the embankment, then hiding itself behind the engine as it hurries forward to the station. The steam is now shut off, and the train, with slackened speed, approaches the platform. The luggage is grasped by owners and porters, the doors are opened for those who are coming out or getting in; the baby is handed to a kind-hearted gentleman, who proffers his services as an extempore nurse-maid in one of the second-class carriages; the seats are taken; and very soon all is ready again for the start.

Meanwhile, the engine has to take in a supply of water; and accordingly the stoker mounts the tender, pulls round the funnel of the water-crane, and, directing it over the orifice of the tender, which communicates with the tank, receives the necessary allowance. The engine-driver is also performing a series of gymnastic evolutions under and around the locomotive, inserting among the works his sort of oil tea-pot. By means of its long spout, he gets the lubricating fluid into queer secret joints and out-of-the way holes; and then, mounting the engine in a free-and-easy style, he stands ready for his journey.

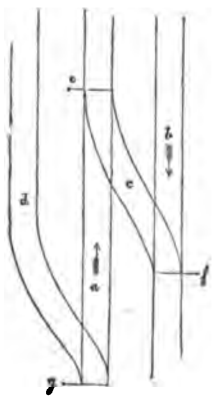
While these processes are going on, one of the porters avails himself of the interval to pass along the line of carriages, in order to ascertain that the little brass boxes fitted to the wheels are sup-

plied with a sufficiency of the well-known yellow grease. It is by means of this that the axles are usually lubricated; and as the boxes open with a hinged lid at the top, they are easily replenished. It may here be mentioned that the grease used for this purpose is composed of tallow, palm-oil, soda, and water—the combination of the proportions varying with the season of the year. Its cost is about 22*s*. a ton.

By the time the observer has witnessed these arrangements, and watched the train off, the platforms are deserted; and in the contrast of the bustle of the past moment and the solitude of the present, he begins to have involuntary reminiscences of Campbell's *Last Man;* and if he steps into the yard, he will find that "the arrivals" also are fast disappearing. The old vehicle, which is a half-breed between an omnibus and a fly, with a cross of a Dutch coach in it, is just off—the driver having at length managed to get the concern under weigh, by dint of some dozen cuts of the whip, ingeniously applied. There is, in fact, a large amount of scientific skill and practical experience manifested by him in this important work, and he is at last successful. The little baker, who has been to the neighbouring country-town to buy flour, is briskly trudging along the turnpike; the horse-dealer, who lives near the "Blue Lion," is already talking with the station-man about certain "parties" who have been bidding for "the bay mare," and informs him confidentially that he means to put the little brown horse in harness in a few days. The large-bodied one-horse fly, with its corpulent rat-tailed steed, which trotted so briskly to the station for its master, who was expected, but who has not arrived, now lags homeward with the peculiar slowness of gait so characteristic of a disappointed vehicle.

In alluding to the arrangements of an intermediate station, it should be mentioned that provision is usually made here for crossing from one line of rails to another. As trains have sometimes to stop at these stations, and then to return on the other line, crossings are necessary. Sometimes, indeed, there are other points on a line at which this can be effected; but there ought to be an efficient system of signalling on the spot, wherever it may be, to keep other trains from coming up while any other train is in the act of crossing. It is important here to observe, that, in order to insure safety, no rails which communicate with crossings or sidings should *meet* the trains on any line, if it can by any possibility be avoided. This will be best illustrated by the diagram. Let *a* be the down, and *b* the up rails. As all down trains will proceed on the down rails,—

for this is a rule which is most strictly observed,—there can never be danger of a down train passing by mistake on to the up rails, and so coming in collision with a train from the opposite direction. If, therefore, it is necessary for an engine or for carriages to be removed from the one set of rails to the other, it must be done by the following means:—The engine must be brought along the down rails till it has passed the points at *e*; the points must then be altered by hand, and the engine being then reversed, it will pass by the crossing on to the up rails *b*,—the wheels righting the points at *f* for this purpose. This process has only to be reversed, in order to take an engine from the up to the down line. The deliberation and security necessary in this arrangement are of the utmost value; and when it is considered how fearful would be the result were trains coming in opposite directions to meet one another, its importance cannot be overrated.



CROSSING AND SIDING.

Sometimes it is necessary to have a siding running forward out of the main line, in order that slow trains may be put in, to enable faster trains to pass without interruption, as represented in the diagram at *d*. Under these circumstances, the points at *g* have to be especially watched; and they are so contrived, by means of a heavy weight, that no train can pass on to the siding unless the points are turned by hand. There is a siding of this kind on the up line at Watford, and at many other places. A similar arrangement is also made at Camden station, by means of which a pilot-engine may be taken from a train which it has been assisting up the incline from Euston, without stopping the train. In this case, just before the train reaches the canal bridge, the first engine is detached, and runs on with accelerated speed, while the rest of the train slackens its pace, and, on approaching the policeman at the facing-points, the engineman motions with his hand, or with his hand-lamp if it be night. The pointsman then changes the points, and the pilot runs into the siding, where it immediately checks its speed, and comes to a stand; while as soon as it has passed, the points are reversed, and the train proceeds on the main line. The operation is one requiring care and coolness, as the policeman does not know till a moment before whether or not the assistant-engine is to continue with the train. Though on one occasion a

train was sent into the siding by mistake, it was soon brought to a stand, and the writer is not aware that any evil has occurred from the practice.

Accidents have in some cases arisen by the rolling of carriages from a siding into the main line, by the action of the wind, or some other cause, and thereby exposing passing trains to danger. To guard against this *self-acting chocks* have been introduced in some situations. These consist of pieces of bent rail or iron bar, so mounted that, while they may be turned out of the way by the wheels of a carriage which is being pushed into the siding, they rise up as soon as it has passed, and prevent it from rolling back to the main line, except when they are held back or clear of the rails by an attendant, which is done by means of a lever handle, similar to those used for working switches.

Some of the most important arrangements of railways are those connected with signal-giving and signal-receiving; and every train that proceeds on a line is regulated in constant compliance therewith, including police signals, stationary signals, semaphore signals, junction signals, auxiliary signals, train signals, special signals, and detonating signals;* while these are modified according as it is day or night, or the weather is foggy. The exhibition of a white signal —whether a flag or a light—signifies "all right;" green indicates *danger*, and shows that "caution" must be exercised; while red is the signal of *danger* which requires that the driver shall immediately "stop." If the line is clear and "all right," the policeman on duty will stand erect with his flag in hand, but show no signal; if it be necessary to proceed with caution, the green flag is elevated; and if caution has to be exercised on account of any defect in the rails, the green flag is depressed.

The signal arrangements at the intermediate stations on the North Western line are various, but all are simple and complete. A station signal is provided for both the up and the down line, one being usually erected at each end of the station, and of the kind represented in the Engraving. On a train stopping, or travelling slowly through an intermediate station, the signal which is painted red on one side is shown for five minutes in the direction from which the train has come, in order to stop any following train; the green signal, on the shorter post, is then turned on for five minutes, to complete the ten minutes' precautionary signal. Exception is made on the Liverpool

* See "Rules and Regulations" for the London and North Western Railway Company, and also those for other Companies.

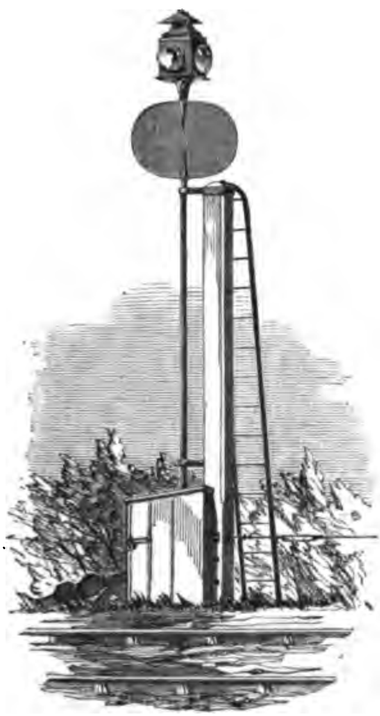
and Manchester line, where the red signal is shown for three minutes and the green for five; and also when an express train or a signal engine has passed, when the green signal only is shown for five minutes. As the lamps and the boards are connected together, the

STATION SIGNAL, WITH COTTAGE.

lamp has only to be lighted at night or in a fog, and the arrangement is complete. When the vane is presented edgewise to the driver of an approaching train, as is seen in the Engraving, it shows that

all is right. The higher mast supports the red signal, and the lower one with the lamp has the green.

Besides these there are auxiliary signals at most of the principal stations, worked by means of wires, which permit their being placed at almost any distance from the spot where they are regulated. These auxiliaries are especially valuable in thick weather; for as they are constructed several hundred yards up or down the line, drivers of engines can obey them when it would be impossible for them to see the station signals with distinctness. They are constructed with only the green or "caution," and the "all right" signals; the presence of the former intimating that the red signal is turned on at the station, and that it is therefore to be approached slowly. In the Engraving of the station signal, the reader may observe the lever by means of which the auxiliary signal is worked.



AUXILIARY SIGNAL.

Where junction lines unite, or lines cross one another at the same level, it is essential that a complete system of signalling should be adopted. The Engraving on page 230 represents a junction or double-signal station. It consists of two masts, to the summits of which fan-like arms and lamps are attached; these convey the desired information to the drivers of approaching trains. When the arm which is painted red, and is always on the left of the engine-driver, is at right angles to the mast, it signifies *danger*, and the train must be immediately stopped; if it be at an angle of forty-five degrees, *caution* must be observed; and if the arm be parallel with the post, it announces the signal *all right*.

In connexion with these junction signals, there is a wooden cottage erected on an elevated platform, that the policeman on duty may see the trains at a distance; there is also an apparatus for working

the signals, and another for shifting the points. In order better to understand the arrangements, let it be supposed that on each of the two lines which here form a junction a train is advancing. The engine-drivers, when they arrive at some appointed spot—at, perhaps, half a mile distant from the station—give a whistle, which would attract the attention of the signal man, supposing that, by some inadvertence, or by the trains being unexpected, he were not to be

JUNCTION SIGNALS.

looking in that direction. As the man has not yet altered the signals, they are both fully on at *danger*, that being their position when at rest; and supposing neither of the arms to be depressed, the trains would pull up, or gently approach the signal station to see the cause of the detention, taking care, at the same time, to be ready to stop altogether at any moment. If, however, all is right, one train may be permitted to advance, precedence being given to the one nearest, or to a faster-running train; and the policeman, putting

his foot into a kind of stirrup, there being four arranged side by side, by these means lowers one of the arms to the *caution* position, and the train, thus signalled, proceeds, while by means of the handles the points are shifted, if this be necessary.

An invention is in use by means of which the signal may be given to engine-drivers as to how far the preceding train is before them. It consists of a copper ball, descending down a pole about sixteen feet high, which at night is lit by lamps: it occupies ten minutes in its descent. It is wound up by clockwork, with scarcely any trouble, as soon as a train has passed, thus showing to the driver of the next train how far the one that preceded him is ahead, this being indicated by the position of the ball upon the pole, and guiding him as to the speed at which he is going. As much, however, depends not only upon the distance of the train before him, but upon its nature—as to whether it is express, slow, or goods—the information conveyed by these signals would be incomplete; while on the North Western Railway, and on other lines where a similar system of signalling is practised, the driver can always sufficiently infer the distance of the preceding train by the fact that, if the line is signalled as *clear*, the other train must have passed not less than ten minutes before. At some stations on the North Western line, an apparatus for signalling to passing trains the nature of the preceding one, has been adopted, but it has been found unnecessary; for, as some of the drivers well remarked, "Why, you see, sir, it would be very well if we did not know what was before us, but we always do; for if it be a train out of the common way, the station-masters tell us."

If a tunnel be in the neighbourhood of a station—as is the case with the Primrose-hill, Watford, and Liverpool tunnels—it is of great importance that an efficient system of signalling should be adopted, aided by electric-telegraph communication from end to end. It is, in fact, now generally admitted, that wherever there are tunnels of any considerable length, the electric telegraph ought to be employed, and that two trains should never be permitted on the same line of rails in a tunnel at the same time. Other precautions are necessary under extraordinary circumstances. Hand-flags in windy weather are bad signals, for they have frequently the appearance of a mere string, while painted boards always show their full size. If on a sudden emergency a red flag or lamp cannot be obtained, a white one, or any other signal waved violently, is a sign of danger.

An Irishman, who appears to have been in some measure

acquainted with the science of signalling, was on one occasion walking along the Great Western line without permission, when he thought that he might reduce his information to practical use. Accordingly, on seeing an express-train approach, he ran a short distance up the side of the cutting, and began to wave a handkerchief very energetically, which he had secured to a stick, as a signal to stop. The warning was not to be disregarded, and never was command obeyed with greater alacrity. The works of the engine were reversed—the tender and van breaks were applied—and soon, to the alarm of the passengers, the train came to a "dead halt." A hundred heads were thrust out of the carriage windows, and the guard had scarcely time to exclaim—"What's the matter?" when Paddy, with a knowing touch of his "brinks," asked his "honour if he would give him a bit of a ride?" So polite and ingenuous a request was not to be denied, and, though biting his lip with annoyance, the officer replied, "Oh, certainly; jump in here," and the pilgrim was ensconced in the luggage-van. But instead of having his ride "for his thanks," the functionary duly handed him over to the magisterial authorities, that he might be taught the important lesson, that railway Companies did not keep express-trains for Irish beggars, and that such costly machinery was not to be imperilled with impunity, either by their freaks or their ignorance.

During the prevalence of fogs, when neither signal-posts nor lights are of any use, detonating signals are frequently employed, which are affixed to the rails, and exploded by the iron tread of the advancing locomotive. All guards, policemen, and pointsmen who are not appointed to stations, and all enginemen, gatemen, gangers of platelayers, and tunnel-men, are provided with packets of these signals, which they are required always to have ready for use whilst on duty; and every engine, on passing over one of these signals, is to be immediately stopped, and the guards are to protect their train by sending back and placing a similar signal on the line behind them every two hundred yards, to the distance of six hundred yards; the train may then proceed slowly to the place of obstruction. When these detonating signals were first invented, it was resolved to ascertain whether they acted efficiently, and especially whether the noise they produced was sufficient to be distinctly heard by the engine-driver. One of them was accordingly fixed to the rails on a particular line by the authority of the Company, and in due time the train having passed over it, reached its destination. Here the engine-driver and his colleague were found to be in a state of great alarm, in consequence of a supposed attack being made on them by an

assassin, who, they said, lay down beside the line of rails on which they had passed, and deliberately fired at them. The efficiency of the means having thus been tested, the apprehensions of the enginemen were removed, though there was at first evident mortification manifested that they had been made the subjects of such a successful experiment.

In the sidings of the stations some spare carriages and trucks are usually kept, which are protected from the weather by sheds. Here, after performing their work, they are submitted to the process of cleaning, internally and externally, all of which is executed with skill and dexterity. At the large stations, and the termini, this duty is divided among several grades of servants, each of whom attends almost exclusively to a special department. After the carriages have been searched by the officer appointed for that service, who takes charge of any articles of value that may have been left by the passengers, in their hurry to depart, they are given into the care of the cleaners. A gang of these set to work with mops and pails, with which they make a vigorous assault on the wood, iron, and glass of the exterior of the carriages; and all is rapidly and efficiently purified. They are then cleansed and beautified by means of sponges, chamois-skins, brushes, cloths, and other utensils, till they are clean and bright. The buffer-rods, and other moving parts of the vehicles, are oiled, the grease-boxes supplied, and the leather and straps on the roof blackened. The inside is also dusted with cloths and leathers, till the blue-cloth seats, sides, and backs are freed from dirt, the windows made to resume their transparency, and all trace of the late journey is effaced.

An important department of the duties of the station, whether it be terminal or intermediate, relates to the receipt and despatch of parcels. The facilities and security which have been afforded by railways in this respect have been highly beneficial. To show the extent of the traffic in this way, it may be mentioned, that it is estimated that more than 2000 parcels are daily booked at the Euston station; while during Christmas the amount of business is enormous. As an example, during one day in Christmas week as many as 5000 barrels of oysters have been despatched from Euston-square. The accuracy with which this part of the business of transport is executed may be estimated from the fact, that not above one parcel in 400,000 is lost.

In referring to an "intermediate," our observations would be incomplete if no reference were made to the refreshment department. Englishmen are generally characterised by their devotion to that

great and primary law of nature which abhors a vacuum, and in their habits, if not in their philosophy, they infinitely prefer the doctrine of the plenum. The railway system has made ample provision for the appetites of travellers, and with many, Wolverton is as remarkable for its eatables as for its vast repairing establishments. Who, indeed, has not talked about Wolverton's far-famed hot coffee, with the five minutes allowed for its consumption, and the various contrivances which have to be adopted to drink it within the time? Who has not laughed at the remorseless way in which, when he asked for milk to cool the scalding beverage, the amiable attendant filled up his cup with *boiling* milk? But there is something even to surpass this. Not many weeks ago a train on the South Eastern line stopped at Tunbridge station, and the passengers rushed out to obtain some refreshment. They had hardly begun to sip their hot coffee, when the bell rang, and the exclamation of the guard, "Now, gentlemen, take your places, if you please," compelled them, however reluctantly, to resume their seats. But, from some cause or other, the train did not start for several minutes, and before it left the station the travellers had the pleasure of seeing their almost brimming cups which they had left on the counter, emptied back into the urns for the next customers! As they rolled away, one of them made an estimate of how many times the same cup might thus be calculated to serve before it was finally consumed; but the result of this calculation, like many other theories, had better pass away without a record.

The refreshment-room has usually the same prominent characteristic. There is the long counter, with its crystal and plate, its mountainous tureens and seething tea and coffee-urns, its *plateaux* of pork-pies, its strata of sandwiches protected by glass bee-hives, and its masses of cakes and buns for the weaker stomachs of that part of the community who fear to venture on sausage-rolls and stout.

One of the handsomest refreshment-establishments on our railways is that at Swindon. The great lunching-room there is a splendid apartment. The counters are placed under a noble arch, the attendants occupying a space between them, so that one set wait on the "feeders" who enter by one of the doors, and the rest on the others. The effect which is produced on the mind of the observer is, that there is a majestic mirror there, and he is inclined to imagine that the crowd on the other side of the arch is the reflexion of the company on the side at which he is standing. One visitor assures us that exactly opposite the place where he stood — in the act of enjoying a glass of sherry and a biscuit—he discovered what he took to be

the counterfeit presentment of himself. But what an extraordinary mirror! he thought; for he saw a prodigious man, with enormous whiskers, ramming a large veal-pie into his mouth with one hand, and holding in the other a tumbler of porter. He looked at the glass of sherry, and gave the biscuit a more vigorous bite—but, alas! it had none of the flavour of the veal and porter; so he discovered that the law of optics was unchanged, and that he had escaped the infliction of so voracious a double-ganger.

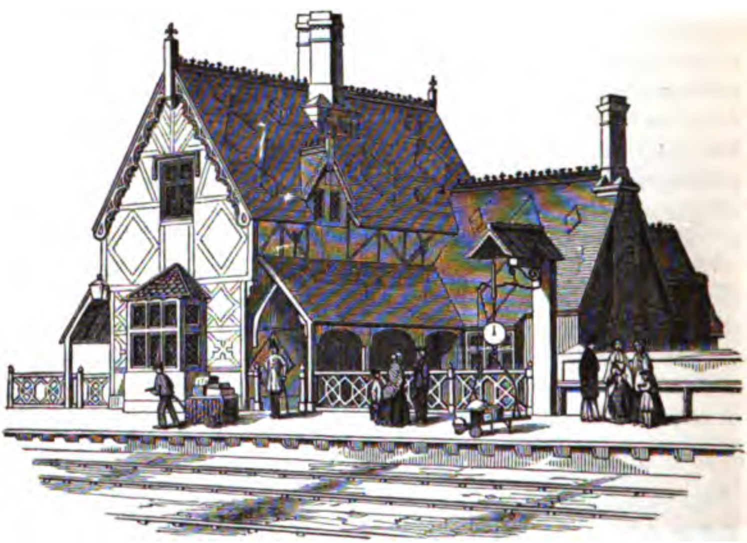
In connexion with the intermediate station, there is usually, as has been already remarked, some establishment for the transport of passengers to and from neighbouring towns or villages. These conveyances vary in their character, from the coach-and-three or four down to the carrier's cart, which waits with due reverence till the afternoon train arrives, in order that it may convey any passengers to the respectable old-fashioned village from which it set out in the morning, and which, as it is full seven miles distant, it will be able to reach somewhere within two hours and a half.

But we must return to the station, where, as night comes on, the sights and sounds grow more strange and awful. Every now and then a great flaming eye makes its appearance in the distance: the gradual boom of its approach grows louder and louder; the thunder of its tread reverberates from afar; the sickly hue of the buffer light is surpassed by the red light of the furnace, as it glares below the wheels; or, the furnace-door being opened, the steam is lighted up till it looks like flame wreathing high up in the air. As the iron gullet of the monster vomits aloft red-hot masses of burning coke, the thundering, gleaming mass rushes past at some fifty or sixty, perhaps seventy, miles an hour; and as it rolls off into darkness again on the other side of the station, with its three red eyes gleaming behind, it seems to burn its way through the sable livery of night with the strength and straightness and fury of a red-hot cannon-ball.

The styles of architecture which have been adopted in the construction of railway stations are very various. Sometimes they are heavy and massive, or large and handsome; in other places they are neat or picturesque; and occasionally they have no one good quality to apologize for their existence. The characteristics of the neighbourhood in which they are erected have in some instances appropriately determined the style. On the Tunbridge Wells and Hastings Railway, the Battle station is Gothic, and is built of native stone, with Caen stone dressings, the roof being covered with alternate bands of plain and ornamental tiles. The Woburn station, of which we give an Engraving, on the Bedford branch of the London and

Birmingham line, is the most picturesque with which the writer is acquainted. The tasteful arrangement of the building, and the contrast of the clean white walls with the oak framings, have, by the skill of the architect, combined to make it a decided ornament to a very beautiful neighbourhood.

Before leaving this part of the subject, a word must be said in reference to Level-Crossing stations. It frequently occurs in the

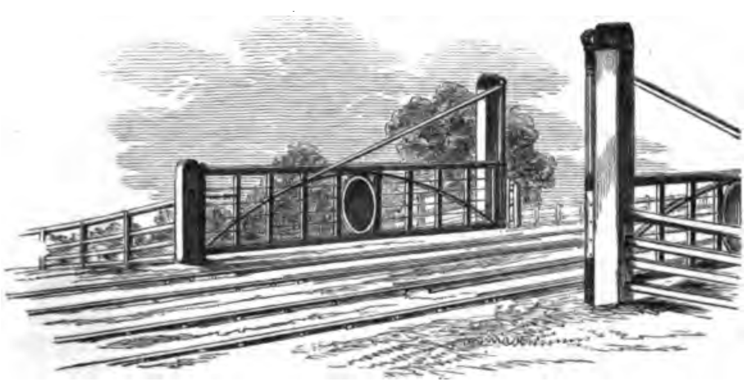


WOBURN STATION.

construction of railways, that they have to intersect existing roads, which it would be impracticable to cross except at the same level. In very many cases, by some modification of the gradient of the line or of the road, the one may be taken over or under the other, and this plan should always be adopted when it is admissible. But where railroads traverse vast extents of almost level country, as in Lincolnshire, Cambridge, and elsewhere, it would be impossible to take the one class of roads over the other except by an unending series of embankments, over which either the line or the common road must pass. If the railway had thus to be conveyed on an elevation, the cost of construction would be enormous; if, on the other hand, the road were made to dip under the line, a hollow would be formed, which would be flooded in winter, or an embankment over

the line would be necessary, which would be very difficult and troublesome of ascent.

To overcome these obstacles, it has been found advisable to take the railroad across the common road at the same level; and in order that the transit may be effected with security both to the trains and to passengers, gates are provided, which prevent access to the line, except when they are opened by the gatekeeper, whose cottage is



LEVEL-CROSSING STATION.

close at hand. The gates are of several kinds and sizes: sometimes two large ones stretch across the line; in other cases, four are employed; while occasionally it is considered that two, which meet together in the middle of the line, and protect it on one side, are sufficient. The accompanying Sketch represents a pair of large gates, such as are commonly constructed on the Great Northern Railway. They are very massive, are strengthened with iron, and are hung on stout timbers, which are deeply and securely imbedded in the earth. They are twenty-six feet and a half in length, and cost about £50. There is a small wicket at one end of each, for the accommodation of foot-passengers. In the middle of each is a large round board, painted red, by means of which a train that is approaching may readily, and at a great distance, see if the gates are closed across the line. At night a red light is substituted, which effectually serves the same purpose.

To the *personnel* of the railway stations, allusion may here be made. The duties which devolve upon the station-master are important. Those who attend to the ticket department have enough to do "between the trains" to make up their books, in which each

ticket that they have given or received has to be accounted for. The accuracy of these is subsequently checked by clerks, in a different department. The booking-office of a station is fitted up with a nest of drawers, divided into labelled compartments, for the purpose of keeping the stores of tickets distinct; and there is also a retail cabinet, in which a supply is contained for every day's use. This is protected at night in front—which is the part facing the clerk—by a sliding board, which usually folds up at each end into a small space. When this is drawn aside a great number of pigeon-holes are seen, each of them being covered with a little piece of wood, which can be raised by the tip of the finger, and a ticket withdrawn at the desire of a traveller.

The number and rank of the officials depend on the business transacted at the particular station, varying from the large establishments at Gloucester or Rugby to the single policeman at Bushey station, who performs all the duties of station-master, clerk, book-keeper, ticket dispenser and collector, signal-man, and porter.

Every officer in charge of a station is answerable for the buildings and the property of the Company thereon, and directs that every part is preserved in neatness and order. He has also to see that the station is kept free from weeds, and that the ballast is raked and preserved, so as to avoid anything like slovenliness in its appearance. A variety of other duties are also committed to him, which it is not necessary here to describe.

The policemen of railways are subject to the supervision of inspectors, who walk over their divisions, and report to their superintendents any irregularities they may detect. It is the duty of every inspector to see that the policemen, pointsmen, and gatesmen are at their posts; that they are clean in their persons, sober, and attentive to their duties, that they are conversant with their orders, and that the points are in good working condition. Their most important work is in their capacity of signal-men, and to these we shall, therefore, reserve further allusion till the structure and uses of signals come under consideration.

Railway policemen at the various stations uniformly exhibit that dignity of deportment which is characteristic of the cloth, and which, though usually combined with perfect civility, must be maintained at all hazards unsullied and unimpeached. It must, however, be confessed that the travelling public sometimes make no small trial of the patience of these officials. Thus they sometimes receive a determined assurance from a sturdy lad of fourteen or fifteen, that he is "under ten," and requires to be conveyed at half-price—an

affirmation which the doubting functionary is obliged to receive with the observation, that he is "certainly a fine boy for his age;" while old ladies of both sexes, having got out at the wrong station several times, go to sleep when they are coming to the place of their destination, and then grumble that they are carried in the wrong direction. Whether or not it is to be regarded as a sign of the times indicative of the redundancy of professional ability, or the value of the policeman's situation, it is not pretended to be decided; but it was at one time mentioned as an *on dit*, that among the "blue-coats" on the Great Western line were eight members of the Royal College of Surgeons, and three ex-solicitors. Railway porters are in general characterised by activity and intelligence, and by a free and easy civility, which partakes neither of the impertinent nor the sycophantic, and is usually manifested by Englishmen, whatever be their social rank.

To the guards a responsible trust is committed. They have charge of the trains—to regulate their speed, and ever and anon to exchange telegraphic communications with the various signal-men on the line, and also with the engine-driver. Each ordinary train on the main lines of railways is provided with two guards; and if the train be heavy, additional guards are appointed to it, at the discretion of the superintendent: short trains on branch lines have one guard. When the train is in motion, it is under the order and control of the senior guard, and he is responsible for the safety of the whole. When there are two to a North Western train, the under-guard rides in the van next the tender. He stands with his back to the engine, and keeps his attention to the train, looking at intervals down each side, and noticing any irregularity in the running, any particular oscillation of a carriage, or any signal which may be made by a passenger. The senior guard occupies the van or break carriage which terminates the train, and it devolves upon him to communicate with the under-guard, and with the driver of the engine. If there be a third guard, he occupies a middle van, and exchanges signals with the other two. On the arrival of the train at a terminus, these officials must not leave the platform till they have delivered over all the parcels as well as the luggage, and if any article be missing, they are to report the fact to the officer in charge of the station. Every guard has also to observe the strictest attention to all the signals of the policemen on the line, and at crossings, intermediate stations, and tunnels, and to obey the orders of station-masters, who have command of the train, unless it is in motion. When an engine-driver wishes to communicate with a guard, he does so on some lines by giving three

short sharp whistles; on others by a deep-toned guard's-whistle, which is considered by some to be less easily mistaken. On hearing the signal, the guard must instantly show that it is understood, and this signal and answer should be made within the first half-mile after starting with a goods-train, and every two miles during the journey. With passenger-trains it should be exchanged every mile on the journey. When the guard wishes at any time to communicate with the engine-driver or fireman, he can do so by suddenly applying the break to the van in which he is seated, and as quickly releasing it; the check that is thus given being quite sufficient to attract attention.

It is thus seen that intelligence, activity, and watchfulness are required on the part of these men, and it is usually found that they are not deficient in these important qualities. Nor in the discharge of their duty to the Company are they negligent of that essential requirement in all public servants—civility to those committed to their care. A few have, indeed, been complained of as overbearing in their manners; but these exceptions, we believe, are "few and far between." An amusing illustration of the formal politeness of one of them occurred at the Reigate station. The guard came to the window of a first-class carriage, and said: "If you please, sir, will you have the goodness to change your carriage here?" "What for?" was the gruff reply of Mr. Bull within. "Because, sir, if you please, the wheel has been on fire since half-way from the last station!" John looked out; the wheel was sending forth a cloud of smoke, and without waiting to require any further "pursuasive influences," he lost no time in condescending to comply with the request.

In noticing the various persons connected with railways, the peculiar duties of the engine-driver ought not to pass unobserved. These men form an important and intelligent class, who have arisen under the exigencies of the times to an arduous post, but one which leads them to be overlooked by the community in general. The great responsibilities devolving upon the engine-men and firemen of our railways, demand that their personal qualifications should be unexceptionable, as to their sobriety, activity, vigilance, and presence of mind in emergencies; for to their care are intrusted the lives of from 150,000 to 200,000 passengers every day, besides property to an almost incalculable amount. It is but just to remark that they have, as a body, proved themselves equal to the requirements of their office, and exhibited a promptitude of resource in instances of difficulty and danger adequate to the heavy responsibilities of their position.

The duties devolving upon the engine-driver are very peculiar and important. It is not merely that he has to regulate the working of an elaborate and costly machine, and to remember as a general maxim, that accidents are to be avoided; but he has to be perfectly calm under circumstances always trying,—to act with decision under exigencies which may arise at any moment,—to discover expedients in unexpected difficulties,—and, as an incentive to the discharge of these duties, he has to remember, not only that valuable property is under his care, but that often very many lives are intrusted to him; while, should any inadvertency arise, his own would be the first to be sacrificed. While the train rushes forward, whether on the brink of some lofty embankment—over the seemingly frail fabric of the wooden bridge—beneath the earthy walls of the cutting, or within the bosom of the embankment, there stands the driver with his assistant, and as the hand of the former rests on the governor of the engine, he regulates the agency by which he is borne along. When we are seated by the rosy Christmas fire, and hear the sleet rattling against the window, or when the freezing blast howls, eager for entrance round the dwelling in which the family group is collected, we sometimes think of the hardy sailor, who rides in his gallant bark on the stormy ocean; but the railway engine-driver, who has

> "To bear
> The pelting brunt of the tempestuous night,
> With half-shut eyes, and pucker'd cheeks, and teeth
> Presented bare against the storm,"

is often forgotten. Yet his position is truly remarkable. Even on a bright sunshiny-day, and at a moderate speed, the work is not for those who have very delicate nerves. The writer has tried it, and found thirty miles an hour under the circumstances to be no despicable rate of travel; for as he rushed onwards he began in some measure to realize the statement of the sailor, who affirmed that he was once in a gale of wind, in which it blew so strongly, that a man who happened to yawn with his face to windward, was obliged to turn round to leeward before he could close his jaws. The writer ascertained also, that merely standing on the engine was not an easy position, and required some practice to be habituated to it; and hence, on more than one occasion, a seat on a chest on the top of the tender has been found to be preferable, while from the summits of embankments it afforded an admirable opportunity of surveying the surrounding scenery, from which the "inhabitants" of carriages are debarred. But to see the engine-driver, when enduring the cold that is produced in winter by evaporation from his drenched clothes, or,

as the gale sweeps over the land in one direction, and he dashes through it at the rate of fifty, sixty, or, it may be, seventy miles an hour in the other, is to witness a strange struggle. Yet on he goes,—the fearful responsibility under which he is placed, keeping his attention undiminished, whether by day or amid the blackness of a wintry night,—rushing down steep gradients, backed by perhaps thirty passenger carriages, each weighing, on an average, five tons and a half—skimming along the summits of the loftiest embankments, and on the edge of precipices, at the foot of which roll the broad and heaving billows of the ocean—or penetrating tunnels, whose darkness can scarcely be distinguished from the impenetrable gloom by which he is elsewhere surrounded—and searching with straining eye-ball for the signal that tells him he may proceed, or the gleaming blood-red light that forewarns him instantly to stay his course under peril of immediate and utter destruction. If an engine could go, without any embarrassment, *through* the fourteen-inch wall of a Camden engine dépôt, as has been twice the case; if in an ordinary accident happening to a luggage-train near Loughborough, the wagons overrode each other till the uppermost one was piled forty feet above the rails; if a train often has a momentum equal to that of a cannon-ball flying through the air, of some ten or twenty tons weight; then a train like that described would pass through a row of houses, if placed in its way, like a musket-ball through a keg of butter; while, if directed by any accident against a mass of solid rock, such as is sometimes to be seen at the entrance of a tunnel, the result would be too fearful to conjecture. But we need entertain no morbid anticipation of such catastrophes; but may rely on the excellence of mechanical science, and the intrepidity and skill of our railway guides; and especially, with humble and grateful confidence, on Him who conducts millions of his creatures every year, in safety and comfort, to the places of their destination.

Our engine-drivers form so important a class, that it may be interesting to know something of the pecuniary compensation they receive for their labours. In giving the rate of wages of engine-drivers and firemen, the arrangement of the London and North Western Railway may be taken as an example.

ENGINE-DRIVERS.

				s.	d.	
Special Class, the number being limited to			20	8	0	a day.
First	„	„	40	7	6	„
Second	„	„	30	7	0	„
Third	„	„	30	6	6	„
Fourth	„	„	20	5	6	„

FIREMEN.

	s.	d.
Twenty, at	4	0 a day.
Thirty	3	9
Twenty	3	6
Thirty	3	3
Twenty	3	0

In noticing the *personnel* connected with the railway, there is a subordinate functionary who should not be altogether overlooked—this is the newsboy. The activity required of the lads who occupy this position, induces business-like habits, and general quickness of mind and manner, which they sometimes bring into practical use. On one occasion a traveller said: "Newsboy! what will you let me have to-day's *Daily News* for? I want it cheap." "Oh," replied the lad, "If you'll give me fourpence, I 'll *sell* you one." The money was immediately handed over, and the traveller thought he had saved twopence by his bargain; but no newspaper being forthcoming in return for the cash, he received the reply,—"Now, sir, as you have *given* me the fourpence, I will, according to my promise, *sell* you the paper; the price of it is sixpence." The joker found that he was practising on one sharper than himself; but was considerately allowed the wished-for *News* on the payment of the other twopence. On another occasion, on a Saturday afternoon, a newspaper boy was passing up and down the platform at Watford, and exclaiming, as usual, to the passengers of a waiting train—"To-day's *Times*, gentlemen, to-day's *Times!*" when a traveller, attempting to be facetious, said,—"What's the use of to-day's *Times?* I 'd give you a shilling for to-morrow's!" when, to his surprise, the boy immediately handed to him the *Sunday Times*. For this, however, the passenger at first refused to give more than sixpence, but his companions made him keep his word, and give the sharp-witted lad a shilling for a sixpenny paper.

CHAPTER XI.

History of the Locomotive—Increased Power of Engines—Outside and Inside Cylinder Engines—Contrast between the Locomotive as it was and as it is—The "Lord of the Isles"—The "Liverpool"—Momentum of a Train illustrated—The Locomotive Factory at Swindon—The Smithery, the Boiler-house, Foundry, Fitting Shops, Erecting Sheds—Cost of Locomotives—The Locomotive before and after its journey—A Locomotive in a Snow Drift—Amount of Work daily performed by Engines—Locomotive Power required for a Railway—Enormous Power of Locomotives, contrasted with the Facility of Direction—Power of Engines in Proportion to their Speed—High Velocities—Consumption of Fuel of Locomotives—Wear and Tear of Engines—Working Expenses of Railways—North Western Railway—Reproduction of Railway Stock—Cost of Carriages—Perfection of Railway-carriage Building—Working Stock of London and North Western Railway—Wonders of the Locomotive—The Atmospheric Railway System—Proposals of Papin, Lewis, Medhurst and Vallance—Pinkus's Pneumatic Railway—Messrs. Glegg and Samuda's Atmospheric Railway—Experiments—London and Croydon Company—Experimental Trips—Construction of the Line—Dalkey and Kingston Atmospheric Railway—Evidence before a Committee of the House of Commons—Objections to the System—Ultimate Failure of the Scheme.

THE history of the locomotive is full of interest, both in itself and in its results. Doubts were long entertained by scientific men as to the possibility of fully developing the powers of the engine, which greatly retarded its successful application. The conviction had firm hold upon the minds of those best informed upon the subject, that the adhesion of the wheels of a locomotive, technically termed *the bite*, would be insufficient for the maintenance of a heavy traffic; and that, though a light engine might be made to run even at a considerable speed, yet if heavy burdens had to be drawn, the wheels would revolve without advancing. Thus it is that

> "Our doubts are traitors,
> Which make us lose the good we oft might win,
> By fearing to attempt;"

for after much time, skill, and money had been expended in devising various expedients to obviate the supposed evil, it was found to be quite imaginary, and that, for all practical purposes, no such difficulty as that apprehended would arise.

To the connexion of the locomotive with the establishment of the Liverpool and Manchester Railway, we have already referred. Despite the doubts of some, and the denials of others, the locomotive was made capable of undertaking the great work of maintaining the interchange of people and of commodities; and as the demands upon its services increased, fresh energies were developed, till we behold it in the comparative perfection in which it now appears before us. But the improvement was gradual. Experience lent its aid to theory, and soon great alterations were found necessary in the form in which it first appeared.

It would be interesting to trace the several steps by which increased efficiency was given to the "steam-horse," as this must be regarded as the most important element of success in the establishment of the railway system; but the briefest allusion must suffice. Though much more was performed by the early engines of the Liverpool and Manchester line than could have been anticipated, yet it was soon found that their strength was insufficient to sustain the shocks and strains to which they were exposed, and repeated and thorough repairs were indispensable. Thus the earlier railways must be regarded as schools for experiment in the construction of locomotives, as numberless projects had to be tried before the desired efficiency could be attained; and, as a natural result, there were engines of almost every diversity of shape and of power on the lines. For many years the locomotive departments of these early Companies had to go through a course of elaborate and expensive improvement, to meet the requirements of a heavier traffic, and of higher velocities than it had entered into the imagination of the most sanguine friends of railways to anticipate. These trials, too, were not made with the calm deliberation which a salutary caution recommended, making good each step in the progress of discovery before advancing further, but amidst the bustle and responsibilities of every-day duties, that could scarcely be discharged within the period assigned. Engines, having known imperfections, but which it was impossible at the time to remedy, had to be employed, and repairs had to be made during the night, in order that the requisite number of engines might be prepared for the work of the coming day.

In this volume we cannot give other than a general account of these progressive improvements. The outer and inner framings were stayed in various parts; iron wheels were substituted for wooden; crank-axles were formed with almost double the amount of metal at first employed; and pistons, piston-rods, connecting-rods,

and brasses were strengthened; till, with the exception of the boiler and cylinders, there was about as much left of some of the original engines as there was of the sailor's knife, which, while declared to be "quite an antique," was currently reported to have recently had a new handle, and several new blades. Alterations so extensive naturally involved a considerable augmentation of the weight of the engine; and thus, from the four tons and a half which the *Rocket* weighed, it before long increased to the ten tons of the *Planet* class.

Other important alterations followed. The cylinders and the machinery by which the working wheels were driven, were originally placed outside the wheels, but they were soon removed to the space between the wheels under the boiler. This was regarded as a great improvement, inasmuch as the cylinders were inclosed in the smoke-box, and protected from cold, and the driving power was made to act nearer the centre of *inertia* of the engine and load. There was, however, a serious drawback; for it required that the axle of the driving-wheels, on which the greater part of the weight of the engine rested, should be constructed with two cranks, so as in fact to be broken and discontinuous in two places. This was admitted to be an anomaly in engineering; but it was allowed because of the countervailing advantages attending the arrangement. More recently, it was found almost impracticable to compress machinery of sufficient power into the narrow space between the wheels; and the cylinders and working-gear have, in some cases, been restored to their original position outside the wheels. This, however, has been objected to, as giving instability to the engine when in motion; and in many cases a return has been made to the former arrangement of the machinery.

Improvement has thus advanced in the structure of the engine; and though it cannot be said yet to have attained perfection, still the contrast which is presented between the locomotive as it was in its earlier history, and as it is now, is as great as that between the poorest hack that ever tottered under a burden, and the racehorse that won the last "Derby."

The £550 early engine, on four wheels, and of five or six tons weight, is now superseded by the six or eight-wheeled engine of £2500, and of twenty, thirty, or forty tons; and though cost and weight are not to be identified with efficiency, yet they are fairly indicative of the extent of the alterations, and, we may say, improvements, which have been made. The successful competitor on the Liverpool and Manchester line was required to draw a load of only

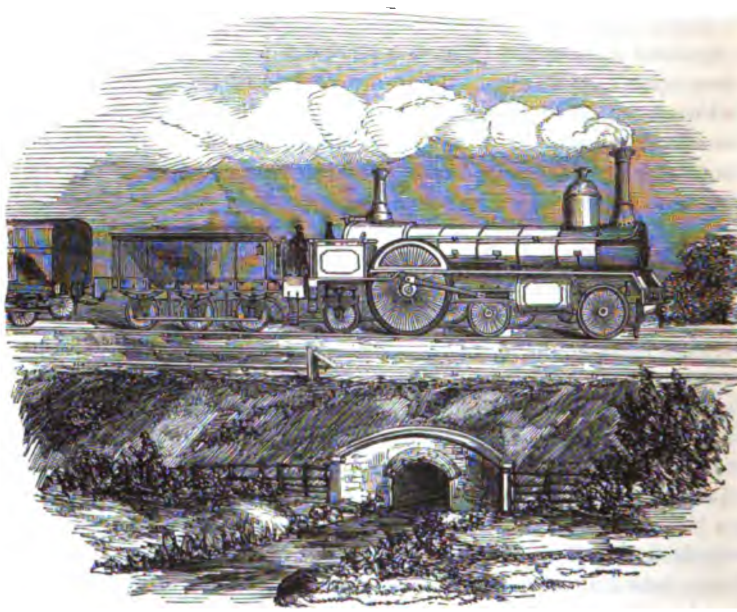
three times its own weight, or a total of less than twenty tons; an engine will now drag after it, without difficulty, thirty passenger carriages, each weighing five tons and a half, at thirty miles an hour; while the express trains on the Great Western proceed, when in motion, at from sixty-five to seventy-five miles an hour; and the goods engines are capable of propelling five hundred tons at twenty miles an hour.

The power of the engines now ordinarily employed on our railways is indeed enormous. On the broad gauge we may take the "Lord of the Isles," which was shown at the Great Exhibition, as the type of the class of locomotives constructed on the Great Western line since 1847; it is capable of taking a passenger train of a hundred and twenty tons, at an average speed of sixty miles an hour, upon easy gradients. The evaporation of the boiler, when at full work, is equal to 1000 horse-power, of 33,000 pounds per horse; the effective power, as measured by a dynamometer, is equal to 743 horse-power. The weight of the engine in working order is thirty-five tons, besides the tender, which, when laden, weighs nearly eighteen tons. The diameter of the cylinder is eighteen inches, the length of stroke twenty-four, the diameter of the driving-wheel eight feet, and the maximum pressure of steam, 120 pounds. The actual consumption of fuel in practice, with an average load of twenty tons, and an average speed of twenty-nine miles, including stoppages, is rather more than twenty pounds of coke per mile. One of the large engines on the Great Western line was nicknamed by the men the "Emperor of Russia," on account of its extraordinary capacity for the consumption of oil and tallow! For the better distribution of the enormous weight of the "Lord of the Isles," it runs on eight wheels. The cylinders are laid horizontally under the front of the boiler, and can be easily examined, together with the rest of the working parts, by going down into the ash-pit, over which the engines are often made to stand in the sheds.

Nor is the narrow gauge behind in the colossal power of its engines. One of the strongest of these is the "Liverpool," built on Crampton's patent, which was also exhibited in the Crystal Palace. This engine contains 2285 feet of heating surface, being 270 feet more than the largest engine on the broad gauge. The diameter of the cylinder is eighteen inches, the length of stroke twenty-four, and the diameter of the driving-wheel eight feet. The engine itself weighs thirty-two tons, and the evaporation of the tubes, when at full work, is equal to 1140 horse-power. The pressure of the steam is 120 pounds on the square inch. The engine is built

with a very low boiler, and the greatest height is on the extreme wheels, in order to insure steadiness.

Another narrow-gauge engine is that represented in the accompanying sketch. It belongs to the London and North Western Company, was built by R. Stephenson and Co., at Newcastle-on-Tyne, is the 729th constructed on the patent of that firm, and is numbered 223 on the lists of the railway. To realise the amounts thus given of the power and the speed attained by locomotive engines is not easy, and in order to understand them more fully, one or two illustrative facts may be mentioned. When a speed of seventy miles an hour is



A LONDON AND NORTH WESTERN PASSENGER LOCOMOTIVE.

attained, a space has to be passed over of about 105 feet per second; that is to say, thirty-five yards must be traversed between the tickings of the clock. If two trains, proceeding at this speed, pass one another, the relative velocity will be doubled; so that, if one of them be seventy yards long, it would flash past the other in a single second of time. Now, according to the experiments of Dr. Hutton, it appears that the flight of a cannon-ball, having a range of 6700 feet, is a quarter of a minute, which is at the rate of five miles a minute, or 300 miles an hour; and hence it follows, that a railway

train, moving at seventy-five miles an hour, has one-fourth of the velocity of a cannon-ball.

In order to understand the processes by which one of these steam monsters is put together, a visit should be made to a locomotive factory; but as this may be difficult, the proceeding adopted in their construction may here be briefly sketched, by a description of the establishment of the Great Western Railway at Swindon. The factory here consists of two large squares, surrounded by workshops, with one or two smaller squares adjoining. In connexion with these is an engine-house, where spare locomotives are kept, and a building resembling a veterinary college, where defects are remedied.

The smithery may be first noticed. This is a long range of buildings, containing 176 forges, with all the "appliances and means to boot" for their effective working. Here all the parts of a locomotive which are of wrought-iron—as axles, piston-rods, connecting-rods, and other pieces too numerous to mention—are produced. Three furnaces are provided in this department, in one of which the scraps of iron which come from the lathes and fitting shops are melted. Near the furnaces are two of Nasmyth's steam-hammers, which are as potent in their work, as they are easy to be directed. Before these hammers were introduced, the forging of huge masses of metal was both a tedious and a doubtful process; now, the requisite power can be obtained to insure security in the work. Yet this mighty engine may be directed by a boy, and is so fully under command, that it can be made to crack a nut without injuring the kernel, or to drive a tin-tack into a piece of wood by successive raps. One of the most important parts of the work which the steam-hammers have to perform, is the forging of the crank-axles of locomotives; and by its aid the huge masses of metal are welded and moulded without difficulty.

The wheel-working is a process of interest; and on the necessity of good workmanship here, it would be superfluous to dilate. The whole of the wheels are formed of wrought-iron, the several parts being forged in pieces and then welded together. In the large eight-feet driving-wheels, there are twenty-four spokes. A wheel consists altogether of more than a hundred pieces. The scenes which are presented in the various operations around the forges, are characterized by a wild magnificence, which must be witnessed to be appreciated.

The next part of the establishment is the boiler-house. The materials of which this part of an engine are made, chiefly consist of sheet-iron prepared for the purpose, the plates of which, when brought to their proper size and shape, are drilled round the edges, so that they may be firmly held together by means of rivets. The

noise which fills this building is most deafening. To speak so as to be heard is impossible, and if it be attempted, the motion of the lips of the speaker is the only evidence that he is talking. The impression produced upon the minds of almost all who enter a boiler-house for the first time is, that the workmen commence a most tremendous clattering of hammers and plates for his special annoyance; as it seems almost impossible that any useful undertaking can be progressing as the result of such a din.

In the foundry, which may next be visited, the cast-iron works are carried on, and a variety of operations may here be witnessed; while in an adjoining building the wood-work of the buffers, and the models in wood for the castings, are prepared.

The fitting-shops form one of the most interesting departments of the establishment. In order to supply the power necessary to put in motion the numerous machines in the factory, there are two powerful engines: one with twenty-one-inch cylinders, and another with thirty-inch cylinders. In the lower turning-shop, the axles, crank-axles, and other large parts of locomotives are finished. Here is a slotting machine, which is so complete in its operation, that all the manual attention it requires is to have the supply of soft-soap and water kept up, to preserve the tool from becoming unduly heated. The value of the great machines employed in this establishment may be gathered from the fact, that the resources of manual labour would be quite insufficient to secure the accuracy of adjustment, and security of workmanship, which are essential. And when the recent demands of advancing mechanical science arose, the necessity of more trustworthy and powerful means became imperative; and a sudden call for machinery of superior accuracy was made. The steam-engine itself, which supplies us with such unbounded power, owes its present perfection to the admirable means thus obtained, of giving to metallic objects the most precise and perfect geometrical forms; and it is this alone, which has provided the means of carrying into practice the accumulated results of scientific investigation in mechanical subjects.

The last department is the erecting-shed, in which all the parts of a locomotive, numbering no fewer than 5416, are put together; and it will be readily conceived that nothing short of the utmost completeness and accuracy, in the finish of these parts, could enable the workmen to combine them in one harmonious and efficient unity. Yet the failure of one screw or bolt, or the bending of one rod, may hereafter involve, not only the costly fabric itself in ruin, but occasion the destruction of property and of life to a terrible extent! So

complete must be the details, so accurate the adjustment, that Mr. Robert Stephenson well remarked, that a locomotive "must be put together as carefully as a watch." The average cost of an engine on the narrow gauge, having a cylinder of sixteen inches diameter, is rather more than £2000; and of an eighteen-inch, £2500; while on the Great Western, the larger class cost no less than £3000 each.

The locomotive having been previously prepared by the "fitters," and others appointed for the purpose, the furnace already burning with its wonted intensity, and the tender laden with a ton of coke, and a thousand or fifteen hundred gallons of water, the engine-driver and fireman make their appearance about half an hour before the time of starting with the train. They immediately proceed to make a critical examination of the various parts of their new friend, the locomotive—for they are as much attached to their particular engines as sailors are to their ships, and allude to them with mingled esteem and affection—in order to see that nothing has escaped the observation of the workmen who have been employed to prepare "her" for the journey. The lamps are examined, to see that they are properly trimmed and are fixed in their several positions; all parts subject to friction are duly oiled; the furnace is replenished with coke; the pumps and feed-pipes are especially observed as the engine moves out of the shed; the wheels, axles, and breaks, are critically noticed; and if any thing is found defective it is instantly remedied, or the circumstance is reported to the foreman on duty, who directs another engine to be substituted.

The preliminaries being completed, the engine-driver procures, from the foreman's office, train, coke, and mileage tickets, which are filled up by him, so as to show the times at which the train started, the number and description of the carriages of which it was composed, the distance performed by the engine, and the coke consumed on the journey,—the accuracy of the last item being certified by the signature of the man from whom he receives the fuel, while he in return signs the coke-man's book for the amount; and having also obtained a time-table, by which he regulates the speed of his engine, seen that his tools and spare stores are in order, and made any arrangements that may appear desirable, the engine proceeds to the main line in front of the train, five or ten minutes before the time of starting. Great caution is exercised in attaching the engine to the train, so as not to move a single carriage, in order to guard against injury to any passenger who may be in the act of stepping in, or alighting from, a carriage at the moment, and the couplings are made to secure the tender to the leading break-van.

On the completion of the day's journey, the steam-horse is unharnessed from the train, and proceeds to what may be called the stables. The question may here arise, whether a locomotive, once at work, may not continue almost indefinitely, since it is known that stationary and marine engines are often kept for many weeks, and sometimes for months, in almost incessant operation? Though the mileage of the engine might be augmented much beyond its present amount, yet not only is the plan usually adopted more economical, but it is indispensable that it should not exceed a certain practical limit. Intervals of repose are as necessary to the rods, and plates, and surfaces of the steam-horse, as to the animal. It becomes impaired, if we may not say fatigued, with its work; its joints become relaxed by its labour, its bolts loosened, its rubbing surfaces heated, and often unequally expanded and strained. Its grate-bars and fire-box become choked with clinkers, its tubes charged with coke; and were its labour continued unduly, its efficiency would be materially diminished, and at a certain point, its power even to move would cease. A due economy, therefore, demands that the work required should not operate to an injurious extent.

When the engine arrives at the locomotive department, it stops over a pit of some depth, excavated between the line of rails, when the fireman removes the grate-bars, and lets the burning coke fall into the pit. He then proceeds with the engine into the stable, which, if of a circular or polygonal form, as is commonly the case, it is brought on to the turn-table in the centre, and the table is then turned till the engine is directed straight towards the stall in which it has to stand.

Between the rails in the stall there is an excavation of such depth, that a man may stand upright in it under the engine, without being incommoded by the machinery. This pit is entered by the artificers, who proceed to examine the works of the engine, to clean them and put them in order, tightening and adjusting all the joints, bolts, and rivets, and oiling and greasing all the moving parts. The tubes of the boiler are cleaned by passing down them long and flexible iron rods, the smoke-box and chimney are put to rights, and the interior of the boiler washed and cleared at proper intervals. In short, the entire machinery is examined and cleaned, and if any small defects have been produced, they are repaired. Should anything further than this be required, it is transferred to the appropriate department.*

* Dr. Lardner.

Before a trial had been made of the full capacities of the locomotive, it was apprehended that the vast masses of snow, which sometimes accumulate in railway cuttings, would effectually retard the advancement of trains, and occasion other serious difficulties. These fears, however, were dispelled in the winter of 1836, when snow had accumulated in the Corcoran cutting of the Newcastle and Carlisle Railway to a considerable depth. On the morning of the 20th of December, the "Hercules" engine approached the spot, where crowds of persons had assembled to render assistance if required, and to see what might occur. On reaching the place, however, the engine dashed without hesitation into the snow drift, and cleared its way through the obstructing mass, while the snow was driven over the top of the engine-chimney, like foam from the bosom of the tempest-tossed wave.

The amount of work usually performed by the engines on our railways is worthy of observation. From returns made by the London and North Western line, it appears that the average daily run of each engine is about forty-five miles, the usual speed being reckoned at about thirty miles an hour, from which the somewhat startling conclusion is obtained, that on a line confessedly working more economically than many, the engines are each worked with trains little more than an hour and a half a day. It must, however, be remembered, that this includes the engines which are under repair or in reserve, and that the distance run per day by those actually in steam is much greater. Thus, on the South Western Railway, the average distance run by the engines in steam per day is 106 miles, and a similar ratio is observed on other lines. The proportion of men to the engines of a railway, is about ten drivers and ten firemen to every sixteen engines.

What then, it may be asked, is the locomotive power required for a line? The reply may be given from two estimates, each of which is, to a certain extent, correct. In the first place, the amount of locomotive power to be employed to draw the traffic on the line, cannot be considered as depending on the length of the railway. On the other hand, it is announced by good authorities, that to stock a line requires an average of half an engine per mile. The latter must, therefore, be regarded as an approximate estimate; for it is obvious that if a million of tons of goods, and ten millions of passengers, have to be annually transported a hundred miles, the same locomotive power will be requisite to execute the work, whether the line on which it is carried be one or two hundred miles in length.

Of the actual number of engines employed on two of the principal lines, the following is a return:—

	Miles.	Engines.
London and North Western*	863	582
London and South Western (including 17 Goods Engines)	244	118

A striking peculiarity of locomotive agency is its extraordinary power, contrasted with its facility of management. Its velocity outstrips the wind, its strength bids defiance to all living forces, and its endurance is measured only by the supply of a simple vapour and the capacity of machinery to resist its expansive power; yet it is regulated at the pleasure of its employer, through means of the simplest construction, and is applied with an ease and certainty marvellously disproportionate to the enormous bulk and terrible power which are controlled. A good illustration of the control exercised by drivers over locomotives is furnished at one of the inclines on the Liverpool line, which is approached at a speed of about twenty-five miles an hour, the "banking engine" having to follow in order to aid in the ascent. Many would imagine that, for the purpose of attaching the new engine, the train would have to stop in order to avoid a concussion when the auxiliary joined. So well, however, is this managed, that a passenger in the train, were he not informed of what was going on, would be altogether ignorant of the change, even if he occupied a carriage close to the engine. On one occasion, however, the banking engine was in front of the train, so that the "hooking-on" became a severe test of the skill of the driver, and the command he had over his iron steed, for the train was approaching at its usual rate. The "banker" ran on for some distance a-head, and then, gradually slackening its speed, a "mutual attachment" was effected in the most satisfactory manner.

In referring to the capacities of engines, it is worthy of observation that their tractive power is greatly diminished in proportion to the increase of the speed attained. This was early discovered; and when engines were very inferior to those now employed, Mr. Nicholas Wood made an estimate, which may here be given as illustrative of the principle referred to. Though the items, considered

* The North Western line proper consists only of 537 miles, but the Company supplies the locomotive power over a total distance of 863¼ miles.

absolutely, have undergone great modification, yet, the relative proportion is probably not materially changed.

Rate of speed in miles per hour.	Load in tons, that can be drawn by a locomotive of ordinary power.
10	250
12½	184
15	138
17½	106
20	83
22½	65
25	50
27½	38
30	28

High velocities are more injurious to the permanent way than low; and it is affirmed that the London and North Western Company would save £20,000 a year by taking off their express trains. But the writer is decidedly of opinion, that on this point too much stress has been laid in some quarters. The principal difference does not arise from the expresses on this line, or on any of the narrow-gauge lines, travelling so much faster, but from other trains stopping so much oftener, thus causing time to be lost directly at the stations, and indirectly in letting the steam off and on in approaching and leaving them. The usual estimate of the time lost in stopping at a station is five minutes, one minute and a quarter in coming to rest, an equal time in getting up the steam, and the remainder for standing at the station.

The Brighton express trains perform the whole distance in an hour and ten or fifteen minutes, and it seems a short time for the journey; but the speed is only about forty miles an hour, which is probably attained by nearly all the passenger trains when fairly "on the run." It is indeed more economical to run on through a station at an even pace than to pull up by shutting off the steam, and applying the breaks; and thus is it on other lines. The fastest train on the London and North Western line is one from Birmingham to London, which performs the distance of 112 miles in two hours and three quarters. To combine a high rate of speed with economy of expenditure, and safety to the traveller, is the object to be gained. It must, however, be confessed that the engines of some Companies seem to be painfully devoid of these characteristics, and have been only fairly designated *slo*comotives; but it is hoped that all, by degrees, will attain the efficiency and security which are shown by many of the better managed establishments.

It must be a source of lasting regret, that agencies, like our iron roads, in themselves so eminently calculated to promote at once public convenience and private emolument, should be hampered by the folly, or the wrongs of those on whom their management, in some instances, has devolved.

A principal item in the cost of working an engine arises from the consumption of fuel. A return of the North Western line shows, that the coke consumed by its engines in order to accomplish a total mileage of 7,532,230, amounted to 116,396 tons, or 260,727,040 pounds, which gives rather more than 34 pounds per engine per mile run. On the Brighton and South Coast Railway, on which the trains are much lighter, a total mileage has been obtained of nearly 600,000 by the consumption of 6345 tons, or 14,212,800 pounds of coke. The average amount required by the engines of the Great Northern line is 31½ pounds a mile; the estimate being for passenger engines, 22·6 pounds a mile, and for goods engines, 43·6 pounds a mile. The cost of the coke and coal a ton is 13*s*. 8½*d*., or 2·46*d*. per train a mile. The total working charges, including taxes and duty, amount to 49·75 per cent. of the gross receipts, and show an average of 1*s*. 7½*d*. per mile run, of which the locomotive expenses are equal to 6·88*d*. a train a mile.

The working expenses per cent. out of the gross receipts of some of the principal Companies have been recently published, as follows:—

Great Western	29½
Brighton	31
North Western	35¾
South Western	36¾
South Eastern	41¾
Eastern Counties*	44

The time during which a locomotive may be kept in efficient condition, of course depends materially on the way in which it is treated. The ordinary estimate, however, is, that if kept in thorough working order, a passenger engine will require new tubes and other heavy repairs, after running an average of about 95,000 miles, incurring an expenditure of about £400. It will then be in a condition to work another distance of 95,000 miles, at the end of which it will need still heavier repairs. When these have taken place, it will run a similar mileage, at the termination of which repairs will be necessary to the amount of about £400; but after running 95,000

* This line labours under the disadvantage of being subject to a heavy contract for it supply of coke.

miles more, the engine will require re-erection, at a cost of about £1000; always assuming that it has meanwhile been maintained in as perfect working condition as possible. The total of these periodical outlays is £2480, and the average 380,000 miles, giving three half-pence a mile as the average deterioration of the machinery. The usual distance run annually by a locomotive is about 30,000 miles, which allows about three years and a quarter as the time at which the periodical repairs become necessary.

The account of the working charges, and the rates and taxes of the London and North Western Railway, for the half-year ending December 31st, 1851, is as follows:—

	£	s.	d.
To maintenance of way	55,886	6	7
To locomotive power	130,957	6	4
To coaching expenses	68,859	18	3
To repairs, and renewals of coaches, &c.	21,043	3	5
To police expenses	20,627	1	2
To merchandise traffic charges	86,750	9	1
To repairs and renewals of wagons	23,232	4	0
Compensation for accidents and losses	9,558	2	6
To general charges	20,626	18	11
To law expenses	12,065	17	2
To schools at Wolverton and Crewe	395	4	10
Total working charges	450,002	12	3
To parish rates and taxes, and expenses in connexion with appeals	23,908	10	7
To duty on passenger traffic	31,920	5	3
	£505,831	8	1

The receipts for the same half-year were:—

By traffic—			
Passengers	851,259	4	10
Parcels	50,803	17	0
Horses, carriages, and dogs	15,146	16	8
Mails	24,338	11	0
	941,548	9	6
By merchandise (less cost of collection and delivery)	398,527	7	10
Coal	46,098	2	2
Live stock	34,369	12	5
Total Traffic*	1,420,543	11	11

A very important department of a railway establishment is that for the supply of the carrying stock, including passenger-carriages of the three kinds, horse-boxes, luggage-vans, parcel-vans, break-vans, carriage-trucks, post-offices, and merchandise wagons of every class.

* The traffic due to the North Staffordshire Company has been deducted.

And when it is considered that the London and North Western line keeps in active service about 1100 passenger-carriages, and more than 6000 goods-wagons of every description, it will be seen that it is not without good reason that in the Crewe establishment there are always from fifty to sixty new passenger-carriages in progress, besides numberless other vehicles

The weight of a first-class carriage on the narrow gauge is estimated at from four and a half to five tons; of a second class, from three and a half to four and a half; of a third, from three to four tons. The average weight of first-class passengers, with their luggage, is reckoned at fourteen to the ton, and of the second-class about fifteen to the ton. In comparison with the narrow gauge carriages, the comparative weight of vehicle per passenger, is as follows:—

Broad Gauge first-class six-wheeled carriages, per passenger			518 lbs.
Narrow Gauge, ditto	four-wheeled	ditto	473 lbs.
Broad Gauge, second-class six-wheeled		ditto	225 lbs.
Narrow Gauge, ditto	four-wheeled	ditto	238 lbs.

Captain Huish calculates the average loads of the passenger-carriages on the North Western line at seven passengers for each first-class carriage, thirteen for a second-class, twenty-one for a third-class carriage, and two tons and a quarter of goods per wagon.

Before the rolling stock of our railways was constructed on the extensive scale which has been found necessary, the cost of a first-class carriage was £430, and of a second-class £300. These are now built, not only in a very superior way in all respects, but at a diminished cost: a first-class carriage, affording accommodation for eighteen passengers, being now constructed for £380; a second-class, accommodating twenty-five, for £260; horse-boxes for about £150, and other passenger vehicles averaging about £100. These prices, however, make no allowance for profit: they are the cost price to the Companies. The carrying stock of the railways of the kingdom has been estimated at more than sixty thousand vehicles, of which about one-tenth are for passengers. The cost of this entire stock has exceeded £4,000,000.

From the perfection of construction which has been attained in the manufacture of railway passenger-carriages, they have had almost complete immunity from accidents; and thus, out of the large stock of the London and North Western Railway, only six wheels have failed during the last four years. Annoyance has been occasioned, and danger incurred in some instances, from the heating of carriage-axles; but by the recent introduction of patent axle-boxes, this evil

will be to a great extent obviated for the future. The same praise cannot be bestowed on the goods-wagons, as in no portion of the railway system has so little improvement been made as in this. The fracture of axles is frequent, the mode of coupling defective, and the want of spring buffers, or even of buffers of the same height and width, renders the destruction of property enormous.

The working stock on the London and North Western Railway, was, on the 31st December, 1851, as follows:—

Locomotive engines (passenger and goods)		582
	Tenders	575
Coaching—	State-carriage	1
	First-class, mails, and composite	586
	Second-class	564
	Third-class	344
	Travelling post-offices and post-office tenders	25
	Horse-boxes	271
	Carriage-trucks	249
	Guards', break, and parcel vans	210
	Parcel carts, trucks, &c.	43
Merchandise—	Wagons	8195
	Sheep vans	232
	Lorries, trucks, carts, &c.	15
	Crib-rails	1155
	Sheets	5150
	Horses	162

In treating the great question of railway locomotion, some reference is necessary to the efforts which were made for the establishment of the Atmospheric Railway system; which, though unsuccessful in its ultimate results, ought not on that account to be altogether overlooked.

The idea of obtaining motion by atmospheric pressure appears to have been first suggested by the celebrated French engineer, Papin, about two hundred years ago. The suggestion, however, was long without any practical result, and seems to have been disregarded for more than a hundred years, when it was successively taken up by Messrs. Lewis, Medhurst, Vallance, and Pinkus, and lastly by Mr. Glegg, who, in connexion with Mr. Jacob Samuda, brought the whole to a practical issue. Great attention was paid to the subject by Mr. Medhurst, who devised, among other plans for its accomplishment, one which, in its principal characteristics, greatly resembles that which was subsequently carried out. In the years 1810 and 1812, he published his scheme, to prove the practicability of his method of "conveying letters and goods by air;" but "these publications," he says, "met with that indifference and contempt which usually attend all attempts to deviate so widely from established customs."

In a pamphlet which he issued in 1827,* he gives a fuller account of the various modes in which it was proposed to accomplish the desired object; the principles of which were—first, the construction of an air-tight tunnel of sufficient magnitude to admit the passage of carriages within it, running upon iron rails, and propelled by forcing in air behind them by pumping machinery, the carriages being made so nearly to fit the tunnel that the air thus forced in could not pass them, but must act upon them as upon a piston; secondly, the propulsion of such carriages in certain cases, in the opposite direction, by exhausting the tunnel in front of them, instead of forcing in air behind them. He proposed, thirdly, the use of a smaller tunnel, containing what may be termed a piston-carriage, for the conveyance of goods within the tube or tunnel, and having a kind of valve which would open during the passage of the piston-carriage, so as to allow a rod from it to pass out of the tunnel, and afford the means of propelling a second carriage for passengers, running upon a railway either above or alongside the tunnel, in the open air; and fourthly, the construction of a railway or a tram-road, in the centre of which should be laid a still smaller air-tight tube, containing a travelling piston, which should be connected, as in the last-named contrivance, with an exterior carriage. One of the modes in which he proposed to connect the carriage outside the tube or tunnel with the piston within it, was by an air-tight water-valve, which, however, would only have been applicable on a perfect level, and with a very low amount of atmospheric pressure; and another, applicable to all levels, was formed by thin elastic sheets of iron or copper, shutting down upon a soft substance, so as to form an air-tight joint, but capable of being readily lifted up to allow the passage of the connecting-bar, by the action of a wheel connected with the piston. In all cases Medhurst appears to have contemplated producing the motion of the piston by forcing air into the tube behind it, and thereby forming a plenum, rather than by forcing a vacuum by exhausting the tubes in advance of it.† He seems, too, not only to have overlooked the inconvenience which would arise in the adoption of his first plan by the conveyance being effected through a continuous tunnel, but also to have formed a very inadequate idea of the degree of atmospheric pressure necessary to produce rapid motion; imagining that in a tunnel of thirty feet sectional area, carriages might be propelled at the rate of sixty miles an hour without the condensation of the air being uncomfort-

* "A New System of Inland Conveyance for Goods and Passengers."
† Penny Cyclopædia.

able to the passengers, who, according to the scheme, would not have been shielded from its effects.

Some years after the publication of Mr. Medhurst's scheme, but before his last and most matured announcement of it, a similar project was advanced by Mr. Vallance, of Brighton, which excited both interest and ridicule. He, also, proposed the conveyance of passengers along a railway laid within an air-tight tunnel, which he proposed to be constructed either of cast-iron or of vitrified clay, the motive power to be applied by the creation of a vacuum in front of the piston-carriage. Experiments proved the practicability of the idea, but the objection against travelling in a dark close tunnel would have been sufficient of themselves to prevent its general adoption.

About the year 1835, Mr. H. Pinkus, an American gentleman residing in England, obtained a patent for a Pneumatic Railway. In this apparatus a cast-iron tube of between three and four feet diameter was to be employed, having a longitudinal slit from one to two inches wide along the side which was to lie uppermost. Two ribs or cheeks, cast with the tubes, along the sides of this opening, formed a channel from four to five inches wide and deep, which, in order completely to close in the tube, and prevent the ingress of air, a valvular cord, of some soft and yielding substance, was fitted, strengthened by being formed upon a peculiarly constructed iron chain, and so arranged that when the valve was laid in its place along the trough, the soft matter would completely exclude the passage of air; while the iron portion of the valve, lying upon and covering the edges of the vertical cheeks, at once protected the cord from injury, and prevented its being forced into the tube by external pressure. "Within this tube was placed a piston-carriage, denominated the dynamic traveller, which was impelled forward by the pressure of the atmosphere in its rear, whenever, by the action of pumping machinery connected with the tube, a partial vacuum was formed in front of it. In the rear of the piston, the dynamic traveller carried an apparatus for lifting the valvular cord out of its seat so as to allow a free passage along the slit or opening of a connecting-bar by which the traveller was placed in communication with an external carriage, called the governor, to which the valves to be drawn were attached; and immediately after the passage of this connecting-rod the valve was restored to its place, its sides being fresh lubricated by an apparatus attached to the governor, and the whole being pressed firmly down by a wheel or roller." Some experiments were made to test the practicability of this scheme,

near the Kensington Canal, but, from some cause of which we are not aware, it was ultimately abandoned.

Time passed on, and the failure of former attempts occasioned a feeling of distrust in reference to the possibility of any practical result; but in 1840, Messrs. Glegg and Samuda brought forward their "Atmospheric Railway" project. In order to give their scheme a thorough test on a large scale, they obtained the temporary use of a portion of the then unfinished West London Railway, near Wormwood Scrubbs, where they laid down a tube of nine inches diameter. The track was of old contractor's rails, very badly laid,—which, it is curious to observe, had formed part of the metals of the Liverpool and Manchester line,—where on an incline of one in about a hundred and twenty a maximum speed of thirty miles per hour was obtained with a load of more than five tons, and of twenty-two miles with a load of eleven tons. So successful were the results obtained during the course of the experiments that were here made, that the Directors of the Dublin and Kingstown Railway determined on the adoption of the atmospheric principle on an extension then projected from Kingstown to Dalkey, the gradients and curves of which rendered it unsuitable for locomotives.

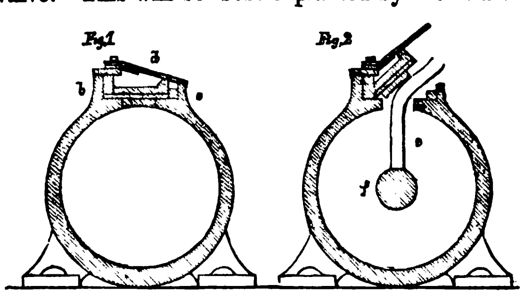
The London and Croydon Company subsequently obtained Parliamentary powers for a scheme for laying down a line of atmospheric railway by the side of their other line from London to Croydon, and making an extension of the same from Croydon to Epsom, an arrangement by which there would have been eighteen miles of atmospheric line, half of which would run parallel with one worked by locomotive engines.

It having been found more convenient to lay the atmospheric railway along the eastern side of the tracks used by the locomotive trains (although the line leading to the Croydon station and to the Croydon and Epsom Railway branches off from that to Brighton and Dover towards the west), this difficulty was overcome by the construction, at the point of separation of the Brighton and Croydon lines, of a very curious viaduct, which crossed the locomotive lines at an extremely acute or oblique angle, over which the atmospheric line was conducted; the rise from, and the descent to, the ordinary level being provided for by slopes of one in fifty. This singular expedient, by which one railway was made, as it were, to take a flying leap over another alongside of which it had been running for miles upon the same level, was regarded as a good illustration of the power which the atmospheric system afforded of crossing roads and rivers without the costly approaches which were necessary for loco-

motives. Trains were brought to the foot of one of these inclined planes, and stopped, so as to deprive them of the assistance of momentum; and from this state of rest they have been drawn up th incline without difficulty.

Upon the part that was completed by the autumn of 1845, experimental trips were run, chiefly for the sake of preparing the servants of the Company, and for testing the machinery, and a speed of thirty miles an hour was obtained with a train of sixteen carriages, and of seventy miles with six carriages. It was subsequently announced by the railway papers, that the astonishing speed of seventy-five miles an hour had been reached with a train of twelve carriages. In order to test the power of working two adjacent lengths of tube with an engine, which might be desirable in case of an accidental failure, two sections, extending together to five miles in length, were exhausted by a single engine with surprising correctness, and trains were run along this double length of tube, at a speed of more than sixty miles an hour.

The chief characteristic in which the atmospheric railway, thus brought into practical application by Glegg and Samuda, differed from those by which it was preceded was the construction of the valve. This will be best explained by the aid of the accompanying



diagrams. *Fig.* 1 represents a cross section of the atmospheric tube with the valve closed; and *fig.* 2 shows it as it appears when open for the passage of the connecting-rod between the piston and the carriage. The tube is laid between the rails, and is firmly secured to sleepers imbedded in the road. On the upper side of the tube is the continuous opening (*fig.* 1) *a*, and a little on either side of it are the vertical cheeks *b* and *c*, the space between which forms the trough in which the valve may lie, which consists of strong leather inclosed between two pieces of iron. In order to exclude the air more completely, the opening edge of the valve is, when closed, hermetically sealed with a composition of wax and tallow, which is indicated in the cut by a dark mark. The valve is further protected by a sheet-iron cover *d*, formed in lengths of about five feet, and shutting down closely on the top of the cheek *c*.

The interior of the tube is completely lined with a soft composition, which fills up all little irregularities, renders the passage perfectly smooth and even, and the piston is so fitted as to be quite air-tight, and yet to move with little friction. It is attached to the fore-end of a rod which is seen at *f* (*fig.* 2), and which carries rollers so fixed as to lift up and open the valve immediately after the piston has passed, thus bringing it into the position (*fig.* 2) which allows room for the connecting-rod *e*, by which the piston is united with the carriages above. The end of the tube in advance of the train is closed, and the air is pumped out by engines; the part behind is left open to admit the air, by the pressure of which upon the piston the train is to be impelled.

During the intense heat of the summer of 1846, the arrangement was disturbed, the composition by which the longitudinal valve of the tube was sealed being found too soft to retain the requisite solidity at such a temperature. This difficulty was thought to be effectually overcome by the substitution of a new and harder composition, and the atmospheric apparatus was completed from Forest-hill to New Cross, whence it was to be continued to London Bridge by the widening of the Greenwich Railway. In a report that Mr. Cubitt, the chief engineer of the line, then made, it was remarked, that "like most new things, the atmospheric railway had taken much longer to get into action than was contemplated," owing to various causes, some of which were, while others were not, connected with the invention itself. He expressed his opinion that "the atmospheric system, as now at work, and in progress towards completion," was "too important a matter either to be hastily extended or hastily thrown aside;" and with this view he recommended the completion of the apparatus between London and Croydon, before anything was done to extend it further.

The atmospheric principle was first practically applied for the conveyance of passengers upon the Dalkey and Kingstown line near Dublin. This line was open for many months, and was worked with regularity and safety throughout all the vicissitudes of temperature which occurred, while the few interruptions which took place seem to have arisen rather from the inexperience of the attendants than from any material defect in the system. High velocities were also obtained, with proportional loads, on an incline averaging 1 in 115, within a course in which the power was applied only during one mile and an eighth. It was thus considered that the mechanical efficiency of the power was established as regards its capacity to convey with regularity, speed, and security, the traffic on one section of the pipe between two

termini; and the evidence of Messrs. Brunel, Cubitt, and Vignoles, before a Parliamentary Committee which considered the merits of the atmospheric principle, showed their belief that no mechanical difficulty would oppose this working of the same system upon a line of any length. That this conviction occupied the minds of the Directors of the Dalkey and Kingstown line is shown by the fact that they applied to Parliament for powers to extend their railway to Bray.

The Committee just referred to also heard the objections of Messrs. Nicholson, Stephenson, and Locke, against the adoption of the principle, which it will be well to notice, as affording us a view of the other side of the case. The arguments employed by those gentlemen related chiefly to the expense of keeping the atmospheric apparatus in an efficient state, and the inconvenience and irregularity attending upon a single line,—there being only one exhausting tube laid down on the experimental line at Dalkey. To these objections it was replied that, with respect to expense, it would scarcely be possible at that time to institute a fair comparison between a system which had then had fifteen years' growth and development, and another, which was yet in its infancy; while, as regarded the second point, the majority of engineers were decidedly of opinion that any ordinary traffic might be carried on with regularity and convenience by an atmospheric line.

The Committee summed up the evidence, and arrived at some important results. They decided that a single atmospheric line was superior to a double locomotive line, both in regularity and safety; inasmuch as it makes collisions impossible, except at crossing-places, and excludes all the danger and irregularity arising from casualties to engines or their tenders.

The opponents of the atmospheric system urged that it would be too expensive, on the ground that it was unsuited to the profitable carrying on of a small and irregular traffic, inasmuch as the greatest proportion of the expenses of haulage on the atmospheric principle were constant, and could not be materially reduced, however varying might be the work to be performed. This would have been, doubtless, an objection to economy, under the possibility of an inadequate traffic; but, on the other hand, as the expenses did not increase in proportion to the frequency of the trains, it would be for the interests of the Company to augment the amount of their traffic by running frequent light trains, at low rates of fare, by which the convenience of the public would be greatly promoted. By locomotive engines, the power is most economically applied in concentrating the traffic in a small number of heavier trains; while upon the atmospheric system

the power would be best employed by dividing the weight to be carried into a considerable number of light trains. Thus, too, the rate of speed at which trains of moderate weight could be conveyed on an atmospheric line would make little difference in the cost of conveyance; while the expense of moving trains by locomotive engines increases rapidly with the speed. "Now, when it is considered," said the report of the Committee, "that we surrender to great monopolies the regulation of all the arteries of communication throughout the kingdom; that it depends in great measure upon their view of their interests when we shall travel, at what speed we shall travel, and what we shall pay, it becomes a material consideration, in balancing the advantages insured to the public by rival systems, to estimate, not so much what they respectively can do, but what, in pursuit of their own emolument, they will do."

The mechanical success seemed complete. "I consider," said Mr. Bidder, in his evidence, "the mechanical problem as solved, whether the atmospheric could be made an efficient tractive agent. There can be no question about that; and the apparatus worked, so far as I observed it, very well. The only question in my mind was, as to the commercial application of it." Even Mr. Stephenson, one of the witnesses who opposed the principle, admitted, that under certain circumstances of gradients and of traffic, the atmospheric system would be preferable. Mr. Brunel proposed that the line should be doubled in those places where trains were intended to meet; and further stated that in a hilly country, with long lines of sufficient inclination to allow the descent of trains by their own gravity, it might be possible to effect this object without the expense of a tube. The gravity of the down train might also be so applied as even to assist the motion of the train in the contrary direction.

How was it, then, that, after all, it failed? The cause may be briefly stated thus. The strength of a machine is limited by the strength of its weakest part; and there was a very weak part in the apparatus of the atmospheric railway. Various devices were proposed and tested, and great ingenuity was shown in the attempts made to discover some means by which the valve might be effectually sealed. This was, of course, essential to the success of the scheme; but the desiderata were not found; and after very large expense had been incurred, and very high hopes had been cherished, it was found necessary to abandon the undertaking.

CHAPTER XII.

Views of "the Old School" in reference to Railways—Peculiarities of Railway Property—Morality of Railway Administration—Railway Officers—Arrangement of the conflicting interests of Rival Companies—The Great Northern and Eastern Counties Lines—Railway Traffic—Averages of Railway Returns—Intermediate and through Traffic—The Great Western Line—Locomotive Tendencies of the Agricultural Population—Meat Traffic—Traffic made by Railways—Unexpected Results—Edinburgh and Glasgow Line—Brussels and Mechlin Line—Employment furnished on Railways—Staff of the North Western Line—Statistics of Railway Legislation for 1851—Statistics of Railways in 1850 and 1851—Statistics of English, Scotch, and Irish Railways—Advantages and Results of Railways—Statistics of Railway Accidents—Commercial Results of Railway Enterprise—Facilities for Locomotion—Reduced Expenditure of Transit—Railway Accommodation for the Poor—Advantages to all—Sanatory Influences of Railway Travelling—Moral Results and Advantages of Railways—Benefits of Travelling—Intellectual Results of Travelling—Geographical Results of Railway Locomotion—National and International Advantages of Railroads—A Hope and a Blessing.

RAILROADS are no friends to me, and I'm no friend to railroads. They have cut up our most beautiful valleys; they have traversed, diverted, and straightened our finest streams; they have swamped our meadows and rendered them difficult of drainage; they have made high embankments over parks and pleasure-grounds, and impeded the most beautiful views; they have made our suburbs unhealthy, interfered with the ventilation of the streets, and occupied our best fields with overgrown stations. For all that, *I* never had a shilling of compensation; and though people do travel more rapidly than they did when I was a boy, I like a coach-and-four better than the fastest shrieking thing you call a railway train that ever ran."

Such are the pathetic expressions of some gentlemen who belong to that link between the past and present, known as "the old school;" and, like many such statements, they both contain and omit much truth. While making the fullest admission of the

vastness of the social, commercial, and political advantages of railways, yet there is another phase of the subject which demands consideration. Railway Directories must remember that great public obligations involve upon them, the discharge of which they cannot avoid. They may talk of the "rights of property," but they must remember that it has also its duties; they may affirm that railroads are the possession of private individuals, who may govern them as they think best for their own interests,—their chief end and aim being the securing of the largest possible dividend; but they must not forget that the public has claims upon them which must and will be enforced, but which it is far better for them to anticipate. If the railways are private property they are public also. If it could be established that they are a clear addition to the means of the nation, purchased by no sacrifices, and balanced by no public inconveniences, there would then be less right of public interference. But it is confessedly otherwise. "The country at large," it has been truly said, "pays a great deal more for railways besides the price of a ticket when one happens to want it." Overlooking many other considerations, it may be asked, Is the cutting off of the means of communication from a hundred neighbourhoods, where they were enjoyed before the stoppage of the coaches, of no account? Are the thousands of miles of highway, depreciated in value, and the consequent loss, to be altogether overlooked? Is the pressure that has been experienced on the national resources,—is the ruin of countless speculators,—is the share which the least speculative of the community had in the general public depression and calamity—to be at once forgotten? The voice of the British nation, and the decisions of the British Legislature, will reply in the negative to such questions; and while the Railway System of this and other lands is undoubtedly among the noblest evidences which can be afforded of the power, energy, and perseverance of man; and though it is admitted to be a most powerful element in the advancement of knowledge, civilization, and religion; yet it is the first duty of the administrators of railway affairs to conduct them in such a manner, that while they are fairly remunerative to the shareholders, they may promote, in the highest degree, the public convenience and the national prosperity.

Having thus, however briefly, referred to the important but neglected question of the morality of railway administration, it will be well to advert to some facts of interest which relate to the economy of railway locomotion. But should any reader be desirous of giving to this subject a special degree of attention, he may be

referred to the elaborate and comprehensive work of Dr. Lardner, whose practical experience and careful elucidation of facts are of great value; for the present purpose, we must be content with but a bare allusion to two or three points which require remark.

The first topic to be noticed has relation to the practical management of our Iron Roads. To provide ample means without extravagance; to give adequate remuneration to competent officers and servants, without prodigality and without parsimony; are duties which are incumbent on all Railway Boards. Doubtless great improvements have been of late effected in these respects,—the position of railway property having demanded that Directors should "pay a stricter attention to arithmetic." The practice must not be permitted of obtaining or dispensing public offices simply for purposes of private emolument. Yet such has been the case. Seats were secured in railway Directories, that the parties holding them might provide for those with whom they were connected, or whom they wished to serve, by dividing among them the appointments of which they had the patronage, "as has been the rule," says a reviewer, "in more than one railway compact, without any regard to fitness." Each may also "take his proportion of profitable contracts. 'No, no,' says the shareholder, 'the law forbids a Director to be a contractor for his own line.' Green, sprouting with verdure art thou, oh! shareholder. When the Scottish edict forbade householders from sweeping their chimneys with a live goose, pulled by a rope, one canny gudeman 'thocht twa ducks would do just as weel.' Of kin to him was the cousin, 'sax-and-thretty times removit,' who, when taking a 'respaccable position as gentleman to a gentleman,' delicately insisted that he would 'serve for puir luve and for the sma' matter—the pennie-fee—he wud aye rather be contentit wi' just the wee things he could pick up aboot the hoose.'"*

One of the most difficult problems which have engaged the attention of those intrusted with the management of our railways, is the arrangement of the conflicting interests of different Companies. When there were only a few lines in the country, there was no danger of much competition; but the gradual interlacing of an elaborate and intricate network of railways, has brought rival interests into operation, which have required full investigation and careful arbitration. Let, for instance, the position of the Great Western Railway, when first constructed, be observed, and there appeared little likelihood of competition arising with other lines; but after a time, the exten-

* Westminster and Foreign Quarterly Review.

sion of the London and North Western on its northern, and the South Western on its southern boundary, have materially changed its relation, and have given birth to a most determined and protracted struggle, to which allusion has already been made, and which has been appropriately designated "The Battle of the Gauges." Thus, too, the North Western, the Great Northern, and the Eastern Counties, have rival claims and interests, which have been brought into active collision, and have required very judicious management to settle. The disputes between the Great Northern on the one hand, and the London and North Western and Midland Companies on the other,—especially with reference to the division of traffic between the metropolis and the towns of York, Leeds, Wakefield, Sheffield, Doncaster, and Lincoln, with which both systems of railway are connected,—required the adjudication of the Right Hon. W. E. Gladstone, who has ultimately succeeded in bringing to something like a definite issue, the complex interests for which the struggle had been prosecuted. The method in which the disputes between the Eastern Counties and the Great Northern have been arranged, will indicate the way in which such questions between rival lines are frequently decided. Thus, the Great Northern Company have agreed to pay to the Eastern Counties sixty per cent. of any earnings from traffic passing over the Great Northern line between London and Hitchin, to and from Cambridge and stations east of Ashwell, on the Royston and Hitchin line; and also twenty per cent. of the earnings from the Eastern Counties traffic, sent from Peterborough to Newark, Lincoln, and Hull, and certain other places north of these towns. Each Company has further engaged to abstain from interference in the district of the other, and to interchange traffic, in the fullest manner, for mutual benefit.

In examining the statistics of railway traffic, many considerations of interest arise, to some of which reference may be made. The first of these is the fact, that the receipts of railways from passengers are made up of small sums. The sum-totals of the returns, great as they are, are formed by the accumulation, not of sovereigns, but of half-crowns and shillings. Manchester and Leeds are excellent terminii for a railway; and it might be supposed that the through passenger traffic would be very considerable, yet it is of little importance, compared with the amount received from travellers for short distances. The Yorkshire traffic is distinct from that of Lancashire: as the trains pass through the tunnel under Blackstone-edge, the passengers are in general reduced to their smallest number,—the increase recommencing at Littleborough and Rochdale, and continuing

to Manchester. The returns of railways in general show that the excursions of first-class passengers are the longest, and yet average but twenty-six miles; and the great majority of these travel much less even than this. For one who makes a trip of a hundred miles, there must be at least ten who travel but ten, otherwise this average could not be maintained. In like manner, second-class passengers average only thirteen miles, and the third-class eleven, while these constitute more than eighty per cent. of the total number of travellers.

It appears that the average receipts of passenger and goods trains are by no means so high as many would at first suppose. Thus we find from late returns, that the average "take" of both classes of trains on the Eastern Counties line was under 6*s*. per train per mile; while on the other lines, the ratio was as follows:—

		s.	*d.*	
South Western	about	6	8	per train per mile.
Lancashire and Yorkshire	"	4	5½	"
Midland	"	4	5	"
York, Newcastle, and Berwick	"	4	4	"
York and North Midland	"	3	10½	"
Manchester, Sheffield, and Lincolnshire*	"	3	9½	"

Railways differ materially in the nature of their intermediate and through traffic. The passengers on the London and Birmingham line are to a great extent of the latter class, there being no large intermediate towns, as on some lines, with the exception of Coventry. On the other hand, the Grand Junction Railway has an intermediate traffic to the manufacturing towns of Wednesbury and Wolverhampton, which bears a considerable proportion to the receipts of the whole line. Now, the Great Western line is in these respects peculiar, differing from the London and Birmingham in the possession of a large intermediate traffic, and from the Grand Junction, and most of the lines traversing manufacturing districts, in the fact that much of its traffic is "first-class." On this line there are the towns of Windsor, Reading, Oxford, Bath, and Bristol, all of which are places of magnitude and aristocratic connection. Besides, it communicates by a junction with Cheltenham and Gloucester. They are also the centres of districts, in which a large number of landed gentry reside; and hence, while comparatively few passengers join the London and Birmingham line at its intermediate stations, and but few private carriages are taken up or set down on the road, these are conveyed

* Including ballast trains, empty special trains, &c.

to and from stations on the Great Western, not only at the large towns, but at Maidenhead, Twyford, Wallingford, Farringdon, Shrivenham, and Chippenham, at all of which suitable accommodation and facilities have to be provided. These peculiarities are obviously points to which especial regard ought to be paid in the administration of railways, in order that the interests of the Companies, and the convenience of the public, may be best secured.

It appears that the rural population travel on railways much more, in proportion to their numbers, than the inhabitants of manufacturing districts. The agriculturists live out of doors, attend markets and fairs, and are led away from home by business more than other classes of the community. Hence it is found that, on lines passing through rural districts, the passenger traffic is much greater, in proportion to the population, than in the densely-peopled manufacturing counties. Some lines, too, are principally fed by a stream of passengers in pursuit of health, pleasure, or both, and this is a highly remunerative species of traffic.

Traffic in live and dead meat is rapidly increasing, large quantities of the latter being sent even from beyond the Tweed to the metropolis. A flash of lightning has been transmitted along the electric wires to the effect, "Send me six or seven hundred stone of fore and hind quarters of mutton;" and on the following morning the meat has been found in Newgate Market; though, when the order was despatched, the sheep were quietly grazing nearly sixty miles away. So complete are the means of communication, that London is becoming more and more the centre of the meat trade; and butchers from various parts of the country visit the metropolis to make their purchases. What railways can do in the transportation of live and dead meat, may be inferred from the fact, that cattle have been sent from Carlisle to Norwich, a distance of 250 miles as the crow flies, in a day and night, without taking them out of the trucks; while the saving of food effected in allowing beasts to ride is by no means unimportant in the general item of national consumption. It has been estimated at twenty pounds each beast for every hundred miles, eight pounds for sheep, and ten pounds a head for pigs.

In estimating the condition of our railways as a great and comparatively modern system of locomotion, it must not be regarded as merely the superseding of an old and inferior agency: for it should be observed, that to a very considerable extent railways have *made* their traffic. This result is one which can scarcely be regarded as anticipated, either by the friends or the foes of our Iron Roads. It

was generally believed that the establishment of the new system would involve the inevitable destruction of the old, and though, doubtless, these expectations were to a great extent realized as regards the coaches, yet it does not appear that even the number of horses have materially diminished from that period to the present. When the Edinburgh and Glasgow Railway Bill passed, the liveliest apprehensions were entertained that the Forth and Clyde and Union Canals would be ruined. But instead of that being the result, the speed of the fly-boats was increased, and the fares were diminished, and the traffic, instead of dwindling away, became greater than it was before the railway was constructed. And here, be it remembered, the distance traversed between the two termini will not fairly come under the denomination of a short distance, for it took the mail coach four hours to accomplish it. It must also be recollected, that if the canal be uninjured in its passenger traffic, much less is it affected in the conveyance of goods, especially in heavy goods. Another instance of this kind is mentioned* in reference to the line which passes from Brussels to Mechlin, where the traffic in merchandise became extremely large from its first opening, and continued to augment. "Yet," adds an author, "in the face of this extraordinary traffic, that on the common roads has progressively 2
increased." And this he proves by reference to the produce of the turnpike-tolls *(péages des barrières)* each year since the opening of the railway.

One of the most remarkable results of the change is, that the number of horses now employed in public vehicles does not appear to have fallen off in any perceptible degree, and that there is not even a proportionate falling off in stage-coaches. This is shown from the return of the miles run, as deduced approximately from the duty paid under the different Stage-coach Acts during successive years, which are as follows†:—

	Millions of Miles run.
In 1836, the largest amount ever collected (the Liverpool and Manchester line was the only one then opened) about	48
" 1839	40
" 1842	43
" 1844	37
" 1847	35
" 1848	31½
" 1849	30

* Weale's Ensamples of Railway Making.

† This information is obtained from the officers of the Stage Coach Duties Department of the Board of Inland Revenue.

The immense activity of the traffic on the English railways, and the extent to which it affords employment to industry, may be to some extent calculated from the following statement of the number and class of persons composing the staff of the North Western Company:—

Secretaries	2
General Manager	1
Superintendents	3
Resident engineers	2
Clerks	966
Police constables	701
Engineers and stokers	738
Porters	3,054
Artificers	3,347
Labourers	1,452
	10,266

The number of horses employed in the local delivery of goods is 612, and the number of vans, 256. This is independent of the goods establishment of Messrs. Pickford and Messrs. Chaplin, the former of whom employ nearly 800 clerks and porters, 400 horses, and upwards of 150 vehicles. The number of men in the service of the London and North Western line averages about 23 persons per mile.

On the South Western Railway, 2,186 men are employed on the 244 miles opened for traffic.

In reference to the present *status* of railway economy, the latest returns furnish the following statements which are worthy of perusal:—

The total number of Acts passed during the Session of 1851, was	61
Including—for incorporation of Companies	12
For extension of time and amendment of Acts	13
For deviations, extensions, and other works for which new capital was required	10
For reduction of capital	7
For additional capital	4
For capital for the reduction of mortgage-debt	3
For lease or purchase	2
Subscription to the undertakings	1

	Miles.
Length of line authorized to be made by the above Acts	194½
To be abandoned	190
Increase in the Mileage	5½

Capital authorized to be raised	£7,584,357
Amount (authorized by former Acts) to be reduced	6,742,739

The number of persons employed on railways open and not open at the end of June, 1850, was	118,859
End of June, 1851	106,501

2

	Miles.
Length of line opened at the end of December, 1849	6,032
" " end of June, 1850	6,307
" " end of December, 1850	6,621
" " end of June, 1851	6,698
" " 1st of December, 1851	6,890
In course of construction, June, 1850	868
" " June, 1851	785
Neither open, nor in course of construction, in June, 1850	4,804
" " June, 1851	4,525
Total length authorized at the end of June, 1850	11,980
" " June, 1851	11,959

2

From the half-yearly report of sixty-seven Railway Companies in the United Kingdom, it appears that the returns on the main, the leased lines, and the branches, for the half-year ending December 31st, 1851, were as follows:—

Receipts	£8,293,720
Expenditure, including rates, taxes, and Government duty	3,568,080
Leaving to pay interest on loans and preference shares, and dividend on ordinary capital expended	4,725,640
The total expenditure being	231,685,960

ENGLISH RAILWAYS.

The traffic receipts on forty-two English lines during the above half-year amounted to	7,233,574
Expenses	3,086,978
Leaving profit to pay interest and dividend, &c.	4,146,596
Total capital expended being	£192,485,802
The length of Railway over which this traffic was conducted was	5,027 miles
Average cost of construction, &c., per mile	£38,290
Receipts	1,439
Expenses	614
Profit to pay interest, &c.	824

SCOTCH RAILWAYS.

The receipts on eleven Scotch lines amounted to	£745,023
Expenses	344,878
Profit	400,145
Total capital expended being	£28,072,572
Length of line over which this traffic was conducted was	912 miles

Average cost of construction, &c., per mile	£30,781
Receipts	828
Expenditure	378
Profit	449

IRISH RAILWAYS.

The receipts on fourteen Irish lines amounted to	£315,113
Expenses	136,223
Profit	178,890
Total capital expended being	11,127,586
Length of line over which this traffic was conducted was	597 miles
Average cost of construction, &c., per mile	£18,639
Receipts	528
Expenditure	228
Profit	300

TOTAL OF BRITISH RAILWAYS.

Total amount of capital authorized to be raised by the above Companies is	£291,239,937
Average amount expended on construction, working-stock, etc., per mile	35,448
Receipts	1,242
Expenses	534
Profit	708

Thus we have a return of profit equal to two per cent. for the half-year on the capital expended. The gross traffic receipts were as follows for the half-year :—

English lines	3·76	per cent. on the capital expended.
Scotch „	2·66	„ „
Irish „	2·83	„ „

The working expenses for the same period were :—

English lines	42·68	per cent. of the receipts.
Scotch „	46·29	„ „
Irish „	45·18	„ „

Of the large and increasing extent to which the means of transit afforded by our railway system are rendered available, the following returns of passengers conveyed in the United Kingdom will indicate :—

Half-year, ending December 31st, 1849	35,078,672
Half-year „ 1850	41,087,919
Half-year „ 1851	47,509,392

Of the security of railroad travelling, the best indication will be afforded from the following return of the accidents incurred by 47,509,392 passengers, during the half-year ending the 31st of December, 1851.

There were persons killed	118
There were persons injured	264
Passengers killed from causes beyond their own control	8
Passengers injured „ „	218
Passengers killed owing to their own misconduct or want of caution	9
Passengers injured „ „	14
Servants of Companies or contractors killed from causes, etc.	30
Servants „ injured „	17
Servants „ killed owing to their own misconduct, etc.	32
Servants „ injured „	11
Trespassers and other persons, neither passengers nor servants of the Companies, by crossing or walking on Railways, killed	38
Trespassers „ injured	9
Suicide	1

The results of railway enterprise, in a commercial aspect, present many features of interest. A London tradesman seats himself in a carriage, at Euston station, at five o'clock in the evening, and if he prefer the first class, he has the luxuries of easy cushions, the warmest of rugs, and a lamp, or perhaps two, to throw a softened light from above over the whole interior. Five hours and a half afterwards he finds himself seated at supper in his hotel at Manchester, while a ride of another half hour would have conveyed him to Liverpool. On the following day he takes a run through the warehouses of various merchants or manufacturers, selects a bale of goods here, and, perhaps, five or ten elsewhere; dines at three or four o'clock; is in the express train on his way to London a little after five again, and sleeps at home, after a jaunt of about four hundred miles, and an absence of only some thirty hours, without the loss of a night's rest. On the following morning, at perhaps nine o'clock, he visits his establishment in the city, and there finds the fabrics which he had finished selecting at Manchester or Liverpool the evening before, no matter what their weight might be, whether fifty pounds, or as many tons. Could all the details of the machinery, all the activity of mind and body, all the skill and ingenuity which have been exercised in the interval of fifteen or seventeen hours, in the packing, transporting, and delivery of these goods, be exhibited to view at a glance, they would probably elicit more wonder than the extravagances of eastern romance. Were these goods endowed with power to look after themselves, to

walk to the station, take their tickets and places in the wagons, secure themselves from the weather by tarpaulins, and unload and deliver themselves at their journey's end, it could scarcely excite more of surprise than the work that is really accomplished. When, therefore, it is recollected that a bale of goods is so much inert matter, depending for its safety on the care of the packers, on a simple label, and on the intelligence brought to bear on it in every direction through which it passes,—that it is one of six or seven thousand such packages which pass through the hands of the Company every day, and that whatever accident attends it—whether it be left at a wrong station, mis-directed, overcharged, lost, or stolen,—there must be such an account kept of it and recorded, that the superintendent of the department may be able to put his finger upon it, and say almost at once where the error originated, and who is to blame, and that unless this were done, in less than two days the whole business of the Company would be thrown into inextricable confusion; some idea may be formed of the undertaking, and of the accuracy and rapidity with which it must be fulfilled.

The facilities which are afforded to graziers, and farmers, and salesmen, in visiting distant markets and fairs, by means of railways, are very important, not merely to the individuals, but to all classes, for all are affected by the result. The transit may now be accomplished in a short time, which a few years since would have occupied many hours. As an illustration of what had to be done in former times, the following fact may be mentioned. A farmer and grazier residing at Braybrook, in Northamptonshire, about eighty miles from London, was in the habit of attending Smithfield market once a week. To accomplish this he had to sacrifice three days and a night, travelling at night, and seldom reaching home till early on Sunday morning. Besides the expense incurred on the way, the fare of the coach was £3 4*s.*, to say nothing of the prejudice to his business occasioned by the length of his absence from home. The journey may now be performed from a station in the neighbourhood of this village in about three hours, the first-class express fare of which is only eighteen shillings.

The reduced cost of railway transit is no unimportant advantage. It was long urged that a monopoly of passenger traffic would debar the poor from the enjoyment of the privilege; and thus, in 1839, it was said that " the injurious effects of the railway system upon the poorer classes of passengers will be more severely felt, as other means of cheap travelling by stage-coaches, carriers' carts, and wagons, are gradually superseded."

Instead of the cost being increased, however, it has greatly diminished. It will be remembered by many, that before the introduction of railways, the mail fares from London to Birmingham were fifty shillings inside and thirty-five out; and by the ordinary coaches forty-five inside and thirty out, exclusive of fees to coachmen and guards, averaging from five shillings to seven and sixpence. Thus, altogether, the expense was fifty-seven shillings for travelling through the whole night, and reaching Birmingham to a late breakfast; now a twenty-shilling fare will give the traveller the accommodation of a first-class carriage, and the liberty of retiring to rest at five minutes past twelve, supposing London to be left in both cases at the same time. 2

Nor is accommodation unprovided for the poor. Thus, on the North Western Railway, a train consisting of third-class carriages, covered in, with side-doors and seats, starts from the metropolis every morning between six and seven o'clock, and arrives at Liverpool, Manchester, and Leeds the same evening—travelling at an average speed of fifteen miles an hour, including stoppages; but when in motion, at twenty-five, to avoid the danger of being overrun by other trains. On its arrival at Blisworth, sixty-three miles from London, it is detained an hour and a half, to allow the mail and three other quick trains to pass, and for the purpose of warming and refreshing the passengers, for whom a large and commodious room is provided. Another half hour is allowed at Birmingham and Derby. The object of these stoppages is, in fact, chiefly to prevent the use of the train by those for whom it is not intended. A similar arrangement is made for "the people of the north."

In the benefits thus conferred on the working classes every rightly-toned heart will rejoice. The statesman may examine the Railway System in its political bearings alone; the soldier may dilate on the means that it affords for the prosecution of military operations, either of attack or defence; the economist may resolve the entire question into one of pounds, shillings, and pence; and the professional man may estimate them in the saving of that time which, to him, is money: but the philanthropist will make these subordinate to higher considerations. He will think of the facilities they afford for the communion of classes and the preservation of international tranquillity; and he will regard the means of health to the body, and relaxation to the mind, which our railways furnish, as well as the intercourse they cherish between domestic and social circles, as of no secondary importance.

On the sanatory influences of railway travelling, a word may not

be inappropriate. It was at first alleged by some that being moved through the air at some twenty or thirty miles an hour would seriously affect the lungs of delicate and asthmatic people; that to such as are of a sanguineous temperament, and are liable to fullness of blood in the head, the movement of trains would produce apoplexy; that the sudden plunging into the darkness of a tunnel, and emerging from it into the light of day, would not fail to give abundant practice to oculists; while the bottoms of deep cuttings or excavations, being necessarily damp, would multiply agues and catarrhs. It would be a work of supererogation to attempt to show that these apprehensions were altogether unwarranted; but it is worthy of observation, that the oscillation of the railway carriage is much less toilsome than the swinging and the jolting of a stage-coach. A medical man of eminence says that, "The former equalizes the circulation, promotes digestion, tranquillizes the nerves, and often causes sound sleep during the succeeding night; the exercise of this kind of travelling being unaccompanied by that lassitude, aching, and fatigue which, in weakly constitutions, is the invariable accompaniment of the ordinary coach travelling, and which so frequently, in such constitutions, produces sleepless nights."

In contemplating the advantages which have accrued to all classes of the community from the establishment of Our Iron Roads, too much emphasis can scarcely be laid on the gain which has been effected in respect to the personal convenience of transit. The roof of a coach was doubtless very agreeable on a fine summer day in a pleasant country, and even on a clear frosty morn in winter the box-seat was not to be despised; but on these privileges the traveller could not reckon. There is now no hazard, as there was then, of being informed that there is "no room"—there are no importunities from extortionate guards to satisfy—no clambering over dirty wheels —no hurting one's shins on sharp irons—no wedging of one's-self amidst piles of luggage on a lofty unsheltered platform, around which numerous legs hung dangling like a dozen brace of black and white grouse; while, if it rains, it is not necessary for one's own comfort that the drip of our umbrella should be turned into a neighbour's neck. And it is at the same time a pleasant thought to many, that while the train bowls along over the iron road, there is no plying of the whip, no foaming mouths, nor turgid veins of generous steeds; but that the giant power which thus swiftly bears us onwards has bones of brass and iron, and nerves and muscles that cannot tire.

The effects which have been produced on the habits and character of the people by the increased facilities of communication which

have been placed within their reach, have been very striking, and are daily augmenting. The railway and the steam-boat have girded the world together into nearer union, and have brought its most distant regions into comparative proximity. The traveller takes his place for a few miles in a South Western train, and finds that the lady seated opposite to him, who is quietly engaged at her crochet, is going to Calcutta; while the luggage of a gentleman in the same compartment is marked with the significant word, "Barbadoes." One gentleman meets another in the city, and is informed that a mutual friend is staying for a few days at Jerusalem, and intends returning home *viâ* the Garden of Eden and India. Distances which our fathers would have thought almost infinite, are now thought little of; we forget to speak of miles, and prefer to mark the duration of a journey by hours, as the most fitting way of pointing out the facilities of a route.

To those who are content with visiting spots of interest and beauty within less surprising distances, the attractions of all parts of our own land, and of sister countries, are laid open. The advertising columns of the newspapers daily present a tempting diversity of scenes worthy of visitation, which are placed within the reach of the tourist. And it is deserving of remark, that while intrinsically worthless objects make the utmost parade of their factitious excellences in glaring capitals and bombastic words, there is something of calm majesty in the simple annals of the announcements of the triumphs of Science, which tell us of new agencies established for the promotion of the comfort, the civilization, and the happiness of man. The lakes of England, Scotland, and Ireland, the spas, the watering-places, the woodland scenery, and the mountains, are all thus brought near in our own land; while, in other countries, classic associations may be revived among spots hallowed by the past, we may be enkindled to patriotic ardour on fields where men of other days have shed their blood on the altars of the land of their fathers, and may be aroused to yet nobler thoughts, and holier resolutions, amid scenes which the history of religion has consecrated in endeared remembrance. Yet, for the accomplishment of these objects, so important in themselves and in their consequences, the increase of the facilities of communication is the essential condition.

The influence of railways has not been restricted to the transference of passengers from one county or country to another, it has shown itself in the attraction or distribution of entire populations. When it was said by Raynal, that if we "travel over all the countries of the earth, wherever we shall find no facility of passing from a

city to a town, or from a village to a hamlet, there we may pronounce the people to be barbarians," he uttered a truth which finds abundant illustration both in itself and in its converse at the present day. A few years ago the citizens of London lived at their houses of business, and comparatively few enjoyed the privilege of possessing suburban residences, to which they might repair after the more public duties of the day were ended. Now the metropolis is daily deserted by hundreds of thousands, who, as morning and evening return, wend their way to business and to home. This has been the result of the increased facilities of communication, and the principle is rapidly finding application on even a broader scale. The merchant who, no lengthened period ago, paid an annual visit to the southern coast with his family, now lives there during perhaps many months, and passes to and from his house of business in London thrice a week, or even daily; and the time occupied in the transit is not yet greater than that consumed in travelling comparatively trifling distances with inferior means of communication. The retirement of rural districts, far away from town, is now sought by large numbers, who, by a limited outlay, can enjoy all the advantages of the country, and yet daily spend several hours in their shops or in their counting-houses. Even the school-boy may now be conveyed every day from home to "academic bowers," many miles away, and thus, in an instance with which we are acquainted, a space of more than a hundred and fifty miles is daily traversed. And when we are considering the social benefits conferred by Our Iron Roads, the interests not of the few are to be regarded, but of the many; and especially ought we to rejoice when the advantages, which the possession of wealth gives to the highest, are brought within the reach of the humblest orders of the community.

But not only are our railways powerfully instrumental in distributing masses of the population, but also in concentrating them into new localities. Under the exigences of the times, Crewe with its 8000 inhabitants, Swindon with its 2000 or 3000 artizans, and Wolverton with 1500, have thus arisen. And not only have the vast buildings been reared in which busy hands may ply the craft of locomotive building and repairing, and in which mighty engines work with colossal powers and tireless energies in the same great undertaking; but some of the Railway Directories have exhibited great interest in the physical, intellectual, and religious welfare of the people in their employ. With this object, plots of garden-ground have been set apart for their use, reading-rooms and libraries have been instituted, "Station-Lending Libraries" esta-

blished, schools, with all the requisite means and appliances, provided, and churches and chapels erected. Nor is it surprising that, under such circumstances, a pleasing feeling of confidence is manifested by all classes of the work-people in their employers, an admiration of the completeness of the details of the Company, and a desire to induce others to entertain similar sentiments. On this matter stress may be laid; for the moral relations which subsist between masters and servants is a topic which it were well for society if better understood and applied.

It is not unworthy of remark that many schemes of social progress which are advancing the interests of the people of this and of other lands, are greatly, perhaps entirely, dependent on Our Iron Roads for their successful prosecution. How vastly have the advantages of our postal system been augmented by the establishment of railways, bringing distant cities into the enjoyment of all the privileges possessed by those least remote, and disseminating intelligence throughout the remotest districts of the empire with inconceivably more celerity and certainty than could ever otherwise have been attained!

What, too, it may be asked, would have been our Exhibition of the Industry of the World, without our elaborate and complete arterial system of communication for the myriads who thronged to the metropolis, to mingle at the great festival at the Crystal Temple of Science and Peace! How were it possible otherwise to have brought together the seven or eight hundred thousand souls who, on one line alone, found special trains awaiting to convey them, at trifling cost, to London; and how could it otherwise have been contrived, that through many provincial towns, crowds of five to ten thousand people should be passing through within a few hours on the same great mission! Without our railways, that great scheme would have been a useless figment, which might have floated in the brain of its princely originator, but it would have been without hope or possibility of realization.

In attempting to gain a correct estimate of the worth of our Railway System, these, and many other considerations, must be duly pondered. The man who simply regards the value of the time and money saved on a journey as the great excellences of Our Iron Roads, takes a most unworthy view of the subject, and omits its highest and broadest results and relations; but he who feels anything of interest in the advance of knowledge, the elevation of the intellect, the promotion of kindly feeling and sympathy between the members of the great family of man, will find here a theme on which he may expatiate with elevated satisfaction and hope.

The individual benefits conferred by the facilities of travel now enjoyed are most important. To make the tour of Europe was once regarded as essential to the completion of the education of a gentleman; and still very many will declare, with old Du Bartas:—

> "O thrice, thrice happy he, who shuns the cares
> Of city troubles."

Never were means of communication so abundant—never was travelling enjoyed at so little trouble and expense. Railways, steam-vessels, carriages, and cabs, await the call of the pilgrim. Servants, who have "no objection to go abroad," offer their assistance in every copy of the daily papers. Carpet-bags, trunks, and portmanteaus, stare us in the face in the streets, longing to be packed. Railway-wrappers, caps, cushions, and guides, are abundant—while no less a personage than Sir Humphrey Davy offers "*Consolations* in Travel."

Should the monotony of a round of toil depress the spirits, a journey, though for a short distance, may cause them to rise like the mercury of a barometer on a genial day. What says Burton to the traveller? "He took great content, exceeding delight, in that his voyage. And who doth not, who will attempt the like? For peregrination charms our senses with such unspeakable and sweet variety, that some count him unhappy who never travelled, a kind of prisoner; and pity his case, that from his cradle to his old age, he beholds the same—still, still, still, the same, the same!"

The change already effected in our own land by the Railway System is most surprising. The country may now be traversed from the South coast to the Borders in a few hours. The extremities of the island are now, to all intents and purposes, as near the metropolis as Sussex or Buckinghamshire were two centuries ago. The Midland counties are a mere suburb. With the space and resources of an empire, we enjoy the compactness of a city. Our roads are contracted into streets, our hills and dales into parks, and our thousand leagues of coast into the brief circumference of a castle wall. Nineveh was a city of three days' journey round, Great Britain can be traversed in one, in its longest dimensions, during the same time. For questions of distance, we are as mere a spot as Malta, St. Helena, or one of the Channel Isles, or as one of the little states of the ancient Ægean. One circumvallation includes all the cities of the island. "A hundred opposite ports are blended into one Piræus, and to every point of the compass diverge the oft-traversed long walls that unite them with our engirded acropolis."

By the union of activity and sympathy thus promoted, the great social, commercial, and political interests of the nation are drawn nearer together. Local distinctions and district prejudices are disappearing for ever, and the unit of British enterprise, wealth, and wisdom, is becoming more compact, energetic, and potent, and more promising of prolonged health and permanent stability. Men who but a few years since scarcely crossed the precincts of the county in which they were born, and knew as little of the general features of the land of their birth as they did of the topography of the moon, now unhesitatingly avail themselves of the means of communication that are afforded to visit spots and explore regions, to which the solicitations of friends, the beauties of scenery, or the charms of historic association, may offer attractions. The spread of ideas, as well as the conveyance of persons and of merchandise, depends greatly on means of transit; men become better acquainted with the condition and habits of their fellow men, and ignorance is diminished before the onward and resistless march of knowledge and of truth. The same principle is applicable to the affairs of other lands. Long-cherished national animosities are lulled, and wither away as the intercommunion of people extends; the once oft-repeated axiom, that proximity of situation between empires necessarily makes them hereditary foes, is repudiated as a defunct absurdity—friendships are making sacred the intercourse of families, who, debarred of means of communication, would otherwise never have met—a selfish patriotism will at length be lost in an enlightened and generous philanthropy! In proportion as intercourse is diffused, the happy period will be hastened when countries will become but as counties,—when, united by the same feelings which now actuate different portions of the same nations, they will regard the practice of settling a disputed question by a mutual slaughter as absurd as it is inhuman,—and will see, that though they may be separated by a diversity of tongue, or by the barriers of an arbitrary geography, yet that they, the children of a common Father, brethren of one great family, are heirs of the same destiny, and that their own highest interests are best advanced by the promotion of each other's welfare, and by the assiduous diffusion over the earth of peace and good-will among men. Let all, then, indulge the hopes, and breathe the benediction of the poet,* as he sung:—

"No poetry in Railways! foolish thought
Of a dull brain, to no fine music wrought,
By Mammon dazzled, though the people prize
The gold untold, yet shall not we despise

* Dr. Charles Mackay.

The triumphs of our time, or fail to see
Of pregnant mind, the fruitful progeny
Ushering the daylight of the world's new morn.
Look up, ye doubters, be no more forlorn!—
Smooth your rough brows, ye little wise: rejoice,
Ye who despond: and with exulting voice
Salute, ye earnest spirits of our time,
The young Improvement ripening to her prime,
Who, in the fulness of her genial youth,
Prepares the way for Freedom and for Truth,
And break the barriers that, since earth began,
Have made mankind a foreigner to man.

"Lay down your rails, ye nations, near and far;
Yoke your full trains to Steam's triumphal car;
Link town to town; and in these iron bands
Unite the strange and oft-embattled lands.
Peace and Improvement round each train shall soar,
And Knowledge light the Ignorance of yore;—
Men, joined in amity, shall wonder long
That Hate had power to lead their fathers wrong;
Or that false glory lured their hearts astray,
And made it virtuous and sublime to slay.

"Blessings on Science! when the earth seemed old,
When Faith grew doting, and the Reason cold,
'Twas she discovered that the world was young,
And taught a language to its lisping tongue:
'Twas she disclosed a future to its view,
And made old Knowledge pale before the new.

"Blessings on Science! In her dawning hour
Faith knit her brow, alarmed for ancient power;
Then looked again upon her face sincere,
Held out her hand, and hailed her sister dear;
And Reason, free as eagle on the wind,
Planed o'er the fallow meadows of the mind,
And, clear of vision, saw what seed would grow
On the hill slopes, or in the vales below;
What in the sunny south, or nipping nord,
And from her talons dropped it as she soared.

"Blessings on Science, and her handmaid Steam!
They make Utopia only half a dream;
And show the fervent, of capacious souls,
Who watch the ball of Progress as it rolls,
That all as yet completed, or begun,
Is but the dawning that precedes the sun."

CHAPTER XIII.

Continental Railways—Railways of Belgium—Systematic Proceedings—Adaptation of the Country as a Field for Railway Enterprise—Cost of Railway Construction in Belgium—Railways of France—Characteristics of Continental Lines—Peculiarities of Continental Travelling—Railways in Spain—Peculiarities of the Country and the People—Railway to Venice—Railways in Russia—Line from St. Petersburgh to Moscow and Odessa—Extensions—Railways in British India—Military, social, political, and commercial Advantages of Railways in India—Present Condition of the Traffic of India—Construction of Railways in India—Routes proposed—Peculiar Difficulties to be avoided—Railways in the United States—Rise and Progress of Railway Enterprise in the United States—The First Railway in America—A Route proposed from the Atlantic to the Pacific—The largest Railway in the World—Grants of Land from the States and from Congress—Cost of American Railways—Table of American Lines—Condition and Prospects of Railway Enterprise in the United States—Speed attained—The "Cow-Ketcher"—Appearance of Railways, and Railway Scenery.

THE railways of the Continent, and in other parts of the world, have many points of interest in which they differ from those of our own country. To enumerate these at length, would necessitate a transgression of our limits; and it must suffice merely to indicate some features of their history, and some of the characteristics which are especially deserving of notice.

Before the great questions of our railway system had received a practical solution, by the construction of the earliest lines in this country, no communications of the kind existed on the Continent of Europe or elsewhere, excepting a few tram-roads in some of the mineral districts, on which, in a few cases, locomotive engines of the rudest description were employed. But the successful results of the system in England, at length attracted the attention of all parts of Europe to the subject; though it was not till a protracted period had elapsed, that the feeling of incredulity which was so generally cherished on the Continent, as well as in this country, was abated.

Belgium was the first of the continental nations to avail herself of the advantage of the new locomotive agency. Political, not less than social and general considerations, urged the expediency of the establishment of railways throughout that country, and while great skill was manifested in the design of the scheme, there was energy in its execution; and thus, at length, the territory was overspread with a railway communication, which has rendered this comparatively small kingdom the highway of a large share of the communications subsisting between some of the chief countries of Europe.

The first proposal made, was the formation of two trunk lines, which should intersect each other at Malines. The length of the cross was to extend from Ostend to Liege, and to be continued by Aix-la-Chapelle to Cologne; while the transverse line was to be carried at right angles to this, from north to south, passing from Antwerp through Brussels, and by Mons to the French territory near Valenciennes, to which city it was to be continued. Several secondary lines were to complete the net-work; the total length of the entire system being 347 miles. The project was no sooner announced than it was adopted by the Legislature, and the necessary enactment was passed on the 1st of May, 1834.

One startling peculiarity of the plan was, that it was undertaken as a national work, to be carried on under national management. The execution of the project was commenced in the month which followed the passing of the enactment; within two years, portions of the new lines were opened for traffic, and in 1844, the 347 miles were completed.

Some parts of the country were very favourable to the construction of railways, although in them numerous rivers and canals had to be traversed by bridges and aqueducts; but in those districts which lay between Brussels and the Prussian frontier, the earthworks were by no means inconsiderable. The portion from Louvain to Ans passes through an undulating country, and is carried by cuttings of an average depth of fifty feet, alternating with embankments of an average elevation of sixty-six feet, up a gradual inclination to a summit nearly five hundred feet above the station at Louvain. In this portion of the line there is a tunnel, which measures upwards of a thousand yards, besides numerous aqueducts, bridges, and viaducts, by which the canals and roads are conducted over and under the railway. "From Ans to Liege, the country falls along the side of the valley of the Meuse, by a steep declivity. Here, in a length of 2,300 feet, there is a fall of 360 feet. This descent is effected by two

inclined planes, worked by two stationary engines of 360 horse power. The average gradient of these planes is one in thirty-three. The prevailing gradient between Louvain and Liege is from one in 340 to one in 250, with the exception of a few short gradients constructed at one in 150. The curves upon this line have generally a large radius, with the exception of a few points where they are laid down with a radius of about a quarter of a mile." *

On the 1st of January, 1848, the amount which had been expended in the construction of the Belgian lines is given as follows, by Dr. Lardner:—

Construction of the road	£4,800,270
Buildings and machinery for the inclined planes	59,544
Buildings and appendages of the stations	402,949
Dependencies of the stations	84,772
Management and office expenses	205,773
Rolling stock	853,168
	£6,406,476

Besides the State lines, there are some others, which make the average cost of the Belgian railways about £18,000 per mile.

The railways of France may be regarded as public constructions. The power of private energy and resources is in that country far inferior to that of England, and though special facilities were afforded to encourage the undertaking of railways by the people, it was found that these were inadequate, and the French Companies now stand in the relation of tenants or lessees of lines, which the State principally made. In many cases the works were in a forward state, the earthworks being constructed, the iron part of the road laid, and the buildings of the stations erected, before they were submitted to public competition, in a manner similar to that adopted with public contracts in England.

The railways of the Continent of Europe generally, have been constructed with a special regard to economy of outlay and of working. The vast expenditure which has been incurred in this country in earth-works, and works of art, has not there been attempted, and the lines are carried along the natural level of the country, instead of the irregularities of surface being overcome. Curves of comparatively short radius are also frequently adopted, so that the railways may wind along those levels which would offer the most economical conditions of construction.

In some cases self-acting planes have been rendered available for

* Dr. Lardner.

the purpose of economizing the labour to be performed. An example of this kind is furnished on the line between Dusseldorf and Elberfeld, where there is a gradient for a mile and a half of one in thirty. When one train is about to ascend and another to descend the plane, an endless rope is secured to them in such a way, that as the engines of both trains continue to work, the impetus obtained by the one descending, may aid the other in its ascent. If two trains are prevented, by delays or otherwise, from helping each other, in order to avoid inconvenience, a reserve engine is kept, with its steam up, at the top of the incline. On a train arriving at the bottom, and requiring to ascend, the pilot is hooked on to the ascending train, and while it runs downwards, it helps the engine attached to the train to perform its work. By these means great regularity is obtained.

The cost of the railways of Germany in general appears to average between £11,000 and £13,000 per mile, the latter item being probably the nearer to the truth. This outlay is only about one-third of that of our English lines.

In glancing at the great system of railway communication extending over the far-reaching limits of the Continent of Europe, the mind is struck by the grandeur of the scheme which has thus brought into intimate relation the towns and cities of distant lands and different tongues.

Continental railways have peculiarities unknown in this country, which appear very strange, and are sometimes rather annoying, to Mr. Bull when he crosses the channel. In England, the traveller goes to the station when he pleases, lounges in the waiting-room, consumes Banbury-cakes, and drinks scalding coffee *ad libitum*, wanders about the platform, and superintends his own luggage, and, in fact, so long as he does not interfere with the convenience of other people, and does not violate the "bye-laws" of the Company, he may do what he likes without let or hindrance. In France the system is very different: instead of the traveller managing himself, he is managed. On procuring his ticket, he delivers up his luggage, pays a *sous* or two, and obtains a receipt, and is then marched into a waiting-room, according to the class of his fare; as if the Company were afraid that, having paid his money, he should not have his ride. When the train is ready, the first-class passengers are liberated, and every one scrambles to his seat with as much agility as circumstances will admit; the second-class travellers follow; and the third are then allowed to deposit themselves in the vehicles provided for their reception. The second-class carriages

have the advantage of being lined with ticking, and are quite as comfortable as the old stage-coaches used to be in this country; but the speed of the trains is only about twenty miles an hour. Some of the officials have a grotesque appearance. Instead of the neatness and simple efficiency by which those functionaries are characterized in our own land, they wear a blue cotton blouse like the country people, to which is added a red belt, and a long, slouching, broad-brimmed hat like the priests. As men of authority, they of course wear swords, and they wield red signal-flags and horns, which give them the combined characteristics of the countryman, the soldier, the priest, and the huntsman. Whether any or all of these peculiarities in the arrangements of our Gallic neighbours are deserving of imitation on the railways of Old England, we leave to the decision of our readers. It is worthy of remark, that the stations and the provision made for the accommodation of passengers are in general superior to those in this country. It is satisfactory to find that important and comprehensive arrangements have been concluded between the Directors of British and French railways for facilitating the communications between this country and the Continent. Continuous transit has been established, not only from London Bridge to Brussels and the Rhine, but, with the exception of the short sea-trip from Folkestone to the French coast, the traveller may proceed direct to Warsaw. A continental railway congress sat for some time at Brussels, and a treaty was concluded by the "high contracting powers" for the general acceleration of the traffic and the simplification of the Customs' dues on the lines of France, Belgium, and Prussia. Two daily expresses now leave London Bridge, and, on reaching Folkestone, the passengers, almost without a pause, step from the train into the steam-vessel, cross the channel in about an hour and a half, and then, by *convoi à grande vitesse*, or express train, on the Great Northern of France, proceed to Paris, Brussels, and other chief points of attraction in various parts of the Continent. The time occupied *en route* is about as follows:—From London to Folkestone, 83 miles, 2½ hours; from Folkestone to Boulogne, 26 miles, 2 hours; from Boulogne to Paris, 170 miles, 6½ hours; or a total from London to Paris, 281 miles, 11 hours; from Paris to Brussels, 281 miles, in 11 hours; from Paris to the Rhine, 529 miles, in 43 hours; from Paris to Leipsic, 757 miles, in 67 hours; from Paris to Warsaw, 1,263 miles, in 114 hours. The speed attained is of course liable to considerable modification; but this statement will convey a general idea of the time occupied on these routes.

It appears that there are great natural difficulties in the formation of any considerable scheme of railways in many parts of Spain. Leaving out of sight the fact that Spain has never yet been able to construct or support even a sufficient number of common roads and canals for her poor and passive commerce and circulation; the geological formation of the country presents obstacles which, if overcome by engineering skill, would yet, in all probability, be too costly to render any extensive projects remunerative. Spain is a land of mountains, which rise everywhere in Alpine ridges, walling off one province from another, and one district from another. The mighty cloud-capped Sierras are masses of hard rock, and tunneling, if attempted, would be requisite on a scale which would reduce that of Box or Kilsby to the delving of the poor mole. Spain, again, is a land of *dehesas y despoblados*. The people hate innovations, abhor being hurried, and in general find the ambling of a mule a sufficiently rapid means of transit. The natives, too, next to their dislike of regularly-sustained labour themselves, have strong prejudices against seeing the foreigner toiling in their service, while the villagers would perhaps rise against the stranger and heretic who came to suck the wealth of Spain.

But supposing the work were accomplished, there would be special difficulties with which to contend. The dispossessed muleteer would not surrender his calling and his means of living without a struggle. "He, the *arraiero*," says Ford, in his Hand-book of Spain, "constitutes one of the most numerous and finest classes in Spain. He is the legitimate Manuel of the semi-oriental caravan system, and will never permit the bread to be taken out of his mouth by the Lutheran locomotive; deprived of the means of earning his livelihood, he, like the smuggler, will take to the road in another line, and both will become either robbers or patriots. Many, long, and lonely are the leagues which separate town from town in the wide deserts of thinly-peopled Spain, nor will any preventive-services be sufficient to guard the rail against the *guerilla* that will then be waged. A handful of opponents in any cistus over-grown waste, may, at any time, in five minutes, break-up the road, stop the train, rob the stoker, and burn the engines in their own fire; particularly smashing the luggage-train. What, again, has ever been the recompence which the foreigner has met with from Spain, but breach of promise and ingratitude? He will be *used*, as in the East, until the native thinks that he has mastered his arts, and then he will be cast out and trodden under foot; and who then will keep up and repair the costly, artificial undertaking? Certainly not the Spaniard, on whose

VICENZA AND VENICE RAILWAY.

pericranium the organ-bumps of operative skill and mechanical construction have yet to be developed."

In noticing continental railways, the Vicenza and Venice line is deserving of special attention. The principal work is the viaduct crossing the Laguna Veneta, which required much engineering skill to complete. In high tides or storms, the waters rise about 120 metres above the level of the sea, and the violence of the waves occasioned great difficulties in laying the foundations, for sometimes the work of days was destroyed in an hour. The base is of the stone of Istria, secured together with Roman cement; the upper parts are of brick. The bridge consists of 222 arches, and is 12,000 feet in length. The style of the parapet is antique, massive where it rests on the arches, and terminating in open column work. In laying the foundation, 80,000 piles of larch were driven; in the whole works, 30,000 cubic metres of earth were excavated; and 7000 cubic metres of rubble, 110,000 kilogrammes of iron, 21,000,000 of bricks, and 5000 cubic metres of Istrian stone. A thousand men were employed on the work, which lasted during four years. The total cost was £186,667.

Thus is Venice—the ocean city—chained by modern enterprise to the mainland. No future Rogers will be able to describe the approach to it as he did:—

> "There is a glorious city in the sea.
> The sea is in the broad and narrow streets,
> Ebbing and flowing, and the salt sea-weed
> Clings to the marble of the palaces.
> No track of men, no footsteps to and fro
> Lead to her gates. The path lies o'er the sea
> Invisible; and from the land we went
> As to a floating city—steering in
> And gliding up her streets, as in a dream,
> So smoothly, silently—by many a dome,
> Mosque-like, and many a stately portico,
> The statues ranged along an azure sky;
> By many a pile in more than Eastern-pride,
> Of old—the residence of merchant kings."

One of the greatest proposals for railway construction which has appeared is the line from St. Petersburgh to Odessa, a distance of 1,600 miles. This line will connect the Baltic with the Black Sea, by way of Moscow, and include all the important cities which intervene upon the route. Besides the vast uninterrupted distances which it is thus intended to unite, it strikes the mind with a strange effect, that in that trip the traveller will pass through a variety of climates, and will be able to accomplish the hitherto unheard-of feat

of proceeding from the cold rigidity of winter into the verdant freshness of summer. He may enter the train at St. Petersburgh, amid frost and snow, late in the winter, and find himself, before he leaves the terminus at Odessa, suffering the heat of summer.

The difficulties which must arise in the carrying out of such a scheme are of course very great. There are the ordinary impediments of engineering; but after the triumphs that have been achieved in other parts of the world, shall we say that anything will be insuperable? But there are, too, the peculiar exigences of those remote regions, the intense cold, the mighty snow-storms, and the greater obstacles of an ignorant people, by whom much must be done.

The grandest scheme of railway enterprise which has appeared, is the formation of a line from Calais to Calcutta, by means of which the capitals of the eastern and western worlds may be brought into the distance of a seven days' journey! Instead of steam-ships, oceans, canals, rivers, and camels, we are to have carriages and locomotives; and, by their aid, continents are to be traversed, mountain-ranges to be crossed, and deserts to be tracked. Instead of harbours there will be stations; instead of passing through straits and seas, we shall fly over viaducts; instead of winding a devious way among sandbanks and reefs, we shall be intersecting hills and whirling through tunnels.

And now for the road. The route by Egypt consists of two sea-stages, besides the channel, making 5,075 miles; that is, from Marseilles to Alexandria, and from Suez to Calcutta. The second is by far the longer, leading the voyager round two-thirds of the Arabian peninsula. The proposed route would be about 5,600 miles from London to the capital of the great Bengal Presidency.

The line is first to proceed from Calais to Ostend. It then advances across a flat, populous, and fertile country to Cologne, in the surrounding provinces, where there are timber, iron, and coal in abundance, while the industry and wealth of the people will offer peculiar facilities for the successful prosecution of the work. Onwards it will proceed to the plains of Augsburg, thence along the flat provinces of Lombardy, it will visit the dark, steep, winding streets of Trieste, on the Adriatic, till the margin of the west is passed, and the east—with its crescents and turbans, its cupolas and minarets, its groves and its blue skies—is entered. Tracing the long valleys of Turkey in Europe, where labour is cheap, and the government most anxious for the scheme, some 1,355 miles will separate Constantinople from Bassorah on the Persian gulf; 455 of which extend eastward from the mouth of the Orontes to the valley of the Euphrates. Long,

wide, open valleys will then receive the traveller, and passing down the beautiful vale of Elyhab, he will whirl along the valley of the mighty Euphrates, whose whole course is about 2000 miles, but the length of which, as occupied by the railway, is about 900 miles. From Babylon to Bassorah on the sea is almost a plain, the inclination being only some six inches and a half to the mile. Reaching Bassorah, the route to be pursued enters Persia, and passing along down the shores of the gulf, no great difficulties will be found. Thence, through Beloochistan, brings the line over the Indus, and from thence he will soon reach the city of Calcutta.*

The projectors of this scheme allow themselves fourteen years for its completion. It is proposed that the 900 miles of the Euphrates valley should be completed first, by means of which, twenty days out of thirty-nine will be saved to the traveller, who will proceed from Ostend to the Mediterranean, then to the mouth of the Orontes, thence by railway to Bassorah, and across the Gulf to India. It is believed that this section may be finished in five years; the European interval may then be filled up in a similar period; and lastly, the portion extending between Bassorah and Hydrabad, on the Indus, by the aid of the projected Indian line, will complete the route.†

The scheme is certainly a great one, and, if practicable, a grand one. And why should its practicability be denied? As great engineering difficulties have been overcome, and what has been accomplished is but an earnest of higher triumphs which shall yet be achieved. Yet the idea is too great to be understood at once in all its meaning and relations. Think of panting over the vast aqueduct of Seleucia—of a tubular bridge hanging over the sea where the mighty fleet of Byzantium kept watch at the gates of Europe—of a branch near the garden of Eden—of a station at Antioch—of a junction to Jerusalem—of an embankment in the salubrious vale of Suediah! Think of taking a change of air on the Euphrates—of migrating, so as to enjoy perpetual spring or summer—of having one house in the north temperate and another in the torrid zone, and dispensing with coal fires and paletots altogether! The poet will not need to say to the cuckoo,—

> "Oh, could I fly, I'd fly with thee;
> We'd make, with joyful wing,
> Our annual visit round the globe,
> Companions of the spring!"

for at the proper season he will find railways advertising cheap trains to some spot three, four, or five thousand miles away, with return

* Eclectic Review.—February 1852. † Ibid.

tickets, and special privileges to children and servants accompanying the family. And beside all this, in the mere power of saying—"As I was taking a trip the other day, I met with a strange adventure about the thirtieth degree of longitude," &c., there would be a happy piquancy.

In truth, nothing could be more delightful, says a writer in the Eclectic Review, than such new powers—"of rushing along an iron road, straight from west to east; of rattling at the heels of a locomotive through many countries in succession; of exchanging, in the course of one week, the bitter winds of England for the sultry calm of Bengal. And what a varied panorama is unrolled by the way! There is an infinite variety of scenes, a motley procession of men. The downs and cliffs of England,—the plains, and woods, and antiquated towns of Germany,—the levels of Lombardy, blooming, though under the Austrian curse,—the mountains and valleys of eastern Europe and western Asia,—the picturesque landscapes of Persia, and the rugged tracts of Beloochistan,—all appear and vanish as we watch the flying panorama.

"When the poets of future ages come to celebrate the varied monuments of the past, they will find in each period a distinguishing class of trophies. Greece will shine in the distance with her matchless art, her temples, and the unequalled beauty of her institutions. Rome will display her aqueducts, her roads, and, perhaps, a relic of her decaying Colosseum, with the Vatican, among other signs of departed systems. Asiatic states will glimmer in the remoteness with their barbaric genius; and younger communities, in later ages, will leave their characteristic monuments. Great Britain, and the happy commonwealth of America, will show their commercial fleets, and the highways they have constructed to join nations with nations. Eminent among the splendid achievements of voluntary enterprise may be 'The Great Eastern, Euphrates, and Calcutta Railway,' bringing India within reach of a holiday trip."

The importance of railways to British India has long been obvious; and the results which will attend their establishment will materially affect the destiny of that colossal empire. The cost of locomotion is now immense. During the last campaign in the Punjaub it was estimated that every man in the British army had cost £150, and of course as much would be required to replace him if he were killed or disabled. The usual allowance on an Indian line of march is one camel to two fighting men, and including the other items of elephants, bullocks, horses, and camp followers, which are always connected with the armies of the east, and which swell

the array to an enormous and unwieldy mass, the expense is prodigious. Omitting everything, however, but the camels, an idea may be formed of the cumbrousness and cost of an army composed of such materials. Suppose that 30,000 men have to be marched to a particular district. These require 15,000 camels, averaging £20 each, which creates a locomotive stock costing £300,000, and which will probably have to be entirely replaced within six months at enhanced prices, to say nothing of the loss of baggage and stores consequent on the defective means of transit. Camels move at the rate of two miles and a half an hour, and it is estimated that they do not average three hundred miles in a month. The vast proportions of the territory of the Indian empire are such, that combined with the slowness of conveyance, the expense of military movements in distant regions appears very extravagant; and the economy and efficiency of railways would produce a revolution of the entire system.

The advantages which would be conferred on the government, in a military point of view, are immense. Napoleon announced the great maxim that the highest effort of the military tactician was to concentrate a given number of men at a given place at a given time; and how much more available would the forces of the East India Company be rendered by increasing the facilities of its communications! Look at the extent of the eastern empire, the vast spaces which intervene between its several military stations, the number of followers who now attend the march of a single battalion of foot, and the importance of railways for the transport of such forces to the scene of duty or of action is obvious. Had there been a railway from Calcutta to Delhi, when the Sikh war broke out, with what facility and economy of blood and gold might the inroad have been repelled! India was won with the sword, and the sword must be ever ready if we wish to retain it, so long as there are hordes of semi-savages on its frontiers, and even within its boundaries, anxious to carry destruction, desolation, and rapine, wherever and whenever the opportunity is presented.

The value of railroads to India in a social and political aspect can hardly be overrated. The tranquillity and safety of India depend largely on the opinion which the people entertain of the resources and of the proceedings of the Government. This, which is true of all countries, is believed to be pre-eminently so of India. We hold in India the anomalous position of governing a foreign race, taking little or no hold on the soil, and in number and physical power contemptible in comparison with the governed, to whom there is hardly one of us to a thousand. The natives of India have

been weary of the caprices, uncertainties, oppressions, and cruelties of oriental despotisms; and believing that they are now ruled more justly and beneficially, they have not objected to the assumption of sway over them, and even regard it with positive satisfaction. It has been well remarked, that however rude we must regard the mode of election, the people of India have chosen us to govern them. We stand, then, in some sense, as the selected conservators of the peace and welfare of the millions of those lands; and the breaking down of our power would be not only the destruction of vast influences for good that are now exercised, but would be the letting loose, perhaps for generations, of all the worst elements of violence and wrong.

On this view of the case, Mr. Chapman* has laid great and just emphasis. And these facts must be well regarded in ascertaining the effects which will be produced by the establishment of railway communication in India. In the territories of the Bombay government, indeed, and in some other parts of India, the older people well remember the violence and disorder of the times of their youth; but in the thickly populated countries which are most nearly connected with the other chief seats of authority, the greater part of a century has passed away since the confusion and insecurity which prevailed under the native governments afforded a contrast with the personal safety realized under the peaceable and regular administration of the British power. But when the past is contrasted with the present in any districts of that vast empire, and from the present we look forward to the future, there is every reason to believe that there is not any one class of measures which can be regarded as more calculated to better the condition, aims, and hopes of the people of India, in a manner obvious to themselves, than the establishment of railways, derived from British science, by British enterprise and skill.

The commercial advantages of railways to the country have been advocated by Europeans and natives of every rank. We might quote the words of many on this point, but we forbear. One extract must suffice. "There can be no doubt," says Baboo Mutty Loll Seal, of Calcutta, "that the country would be largely benefited by the introduction of railways. Whether they would pay is a question which experience only can answer; my decided opinion, however, is, that lines connecting our great interior marts with this city could hardly fail to yield a large return on the original outlay. If an industrious and thriving population numbering about a

* The Cotton and Commerce of India. By John Chapman, founder and late manager of the Great Indian Peninsular Railway Company. 1851.

hundred millions; a large, active, and daily expanding internal traffic; cheap land and labour, with most of the necessary materials for construction on the spot, at prices equally low, and perfect security for person and property, are elements that will command success, then it is certain that a more promising field than Bengal for the investment of railway capital could not be found. I speak exclusively in a commercial sense. . . In fact, the more I look at this subject, the more satisfied do I feel that the introduction of a well organised system of railway communication into Bengal, would prove not only highly advantageous to the Presidency itself, but also to the shareholders, by yielding them a liberal and steady return for their capital." Nor should it be imagined that the intercourse of the people and the conveyance of merchandise from one part of India is a matter of minor importance, even with the limited resources now within the power of the people. Inconvenient and laborious as are the modes of conveyance, the communications are carried on to a large extent. As illustrative of this statement it may be mentioned that of the population of the valley of the Ganges, numbering about fifty millions, there annually pass between Calcutta and Mirzapore some 60,000 passengers by native boats, 2000 by steamers, and more than 500,000 by land conveyances; while the goods conveyed by land and river in one year are between two and three million tons. The goods-traffic for one year on the Cawnpore and Allahabad road, was carried by more than 100,000 carts, 170,000 camels, and 63,000 coolies.

To the great railway which has been planned by Mr. Simms, who is the engineeer deputed by the East India Company, to report upon the question, and whose report was adopted, we may now briefly advert. From Calcutta the line takes a northerly course along the right or west bank of the Hooghly, continuing in the same direction for a few miles above Barracpore, where it crosses the river and takes a westerly direction. Following the valley of the Barrakur, it proceeds along the range of hills at gradients which will never exceed the usual power of the locomotive. The trunk line then advances, a little to the south of Benares, to Mirzapore and Allahabad, where it crosses the Soane; a branch strikes off to Benares, which, at a very acute angle, joins the trunk again by a perpendicular line on Chunar. At a distance of nine hundred miles from Calcutta, the line reaches Delhi. This estimate includes thirty miles for contemplated deviations; and it is expected that it will be completed for £17,000 a mile, or £15,295,000 altogether. In this calculation every requisite is made to secure a perfect construction of the line, so as to ensure its most safe and economical working afterwards; and it is at the

same time assumed, that in bridges, stations, and other erections of a similar kind, simplicity of design will be adopted, and native materials and appliances used.

By the terms made between the Railway Company and the East India Company, the former undertake in the first instance to construct, and then to keep up and work, two sections of the proposed line between Calcutta and the north-west provinces of India, one section in Upper, the other in Lower India. They also engage to spend thereon the sum of three millions sterling, upon which the East India Company guarantee a minimum dividend of five per cent, provided that the amount be paid into their treasury within three years from the first signing of the contract between the two Companies. This guarantee is to continue for a period of twenty-five years on the sum of three millions, the interest commencing when £100,000 is paid.

In the construction of railways in India, it will be remembered that some important items of expense will be saved, which form a large aggregate in their formation in Europe. The land is obtained gratuitously—building materials are mostly much cheaper in India than England—there are no Acts of Parliament to be fought for, nor liberal agents to be paid, and no post-horse duty, or poor-rates; so that it is estimated by those who ought to be competent judges, that the calculations of the cost of the line are much too high. The earth-works are confessed to be of no great magnitude over a large extent of the line; and Mr. Simms, the East-India Company's engineer, states, that the heavy works on the whole distance will be for the most part of masonry, and that upon the whole, it is not expected that there exist in the world many lines of equal length requiring so small an amount of earthwork to be performed. The expense which will be incurred in the formation of bridges, to cross the large rivers, will of course greatly depend on the talent of the engineer, and the ingenuity and experience which he may exhibit in combining compactness of design with the requisite strength and durability.

There are some points which it is necessary to regard in the construction of railways in India, which are deserving of notice, from their novelty to those only accustomed to the ordinary wants and means of European lines. The question of providing against periodical rains and inundations is naturally one of importance. On this point the engineers report that, with a judiciously selected and well constructed line, they do not apprehend any serious mischief from this cause; their view being grounded on the practicability of keeping

the ordinary bounds and roads in efficiency by a trifling outlay. They, however, remark, at the same time, that though their opinions are based upon the experience of what they have witnessed, as the effects of seasons when floods have been unusually high, both in Bengal and the upper provinces, yet that it was possible in after years for unprecedented inundations to occur, which might cause serious damage to works constructed with a view to resisting only the highest floods hitherto known.

Another point of interest is the effect which may be produced by the continued action of violent winds, and also of a vertical sun. Though these influences would be more felt in working the trains at high velocities, yet the great point to be guarded against is the effects of friction upon such parts of the engine and carriages as might be exposed to the most intense heat. With regard to the ravages which insects and vermin might make on the timber and earthworks, the engineers state that they consider that these evils may be overcome. "If," says the report, "the information that the commission received be correct, that the destructive action of insects upon the teak and iron-wood of Arracan amounts to nothing, or next to nothing, that question is at once disposed of; but should further investigation show that such is not the fact, recourse must be had either to the use of stone, or to the employment of one or more of the various preparations for timber now in use in England, which it is probable may also be found desirable on the score of economy, to render the timber more durable: this, however, at present, is by no means certain. Captain Western, who has been in Arracan, states, that he would not guarantee teak as resisting damp and insects, but ironwood he knows, from practical experience, to resist both; and has seen a post taken up, after having been in the ground fifteen years, as sound as the day it was put in."

Nor is any serious apprehension entertained in reference to the action of ants and vermin upon the earth-works. There is no doubt that earth-works in the upper provinces, constructed in a loose soil, have occasionally been damaged by the undermining of rats, crabs, otters, and other burrowing animals; but it would simply require the vigilant discharge of the duties of the overseers and labourers of the line, to prevent any serious evil from arising from such a cause. The attention, too, of those parties who had charge of portions of the line passing through Young Saul forests, would have to be directed to the prevention of vegetation on the permanent way. Captain Boileau mentions, that so fertile is the soil, and so rapid the growth of plants and trees in some parts of India, that after they

have been cut down, to clear the way for trigonometrical operations, they have been known to spring up again to a height of fifteen feet in two years; and in some districts the rapid growth of Palma Christi, the castor-oil plant, the gigantic reed called surkunder, and narrul, and many other such productions, might occasion considerable trouble, though the strong roots of the latter, he remarks, are admirably adapted for giving stability to an earthen bank. A writer, in commenting upon this statement, says, that such results could only arise from neglect. "Beautiful, indeed," he says, "are the moss and creeper-clad ruins of India, more particularly those of Bassein, and the ancient city of Gour, which last extend over a space of fifteen miles; the peepul there stands sentry in the centre of the palace gate, and the arms of the gigantic bannian embrace its crumbling walls: but all this is the effect of centuries of neglect."*

The old English blood that flows in the veins of our Transatlantic brethren, combined with those natural peculiarities by which they are characterized, would prevent their ever being far behind "the old countries" in availing themselves of the vast advantages that flow from the construction of railways.

The railway undertakings of the United States have nearly all been the result of private enterprise, called into action to meet the requirements of the particular neighbourhood or districts through which they pass. As in England, there has been an almost total absence of any great design, or connected system of national advancement in their first adoption. The disadvantages arising from this have not been so great as might be imagined; for the formation of one line of railway, in any given direction, prepares the way for its extension beyond the limits first proposed, and, indeed, soon renders such extension a matter of social necessity. Through the adoption of what may be called the *piecemeal* system, it undoubtedly happens that lines are formed which do not fulfil, in the highest degree, the full and general benefits which would have arisen from a more comprehensive plan, and the best route between the more important points of the country is scarcely likely to be selected; but it must be remembered, that the railway system of this country, and of the United States, has been the growth of a principle unknown in its relations before, and the consequences of which it was impossible to have fully anticipated.

The railway system of the United States may be considered to have commenced in 1830. The first line in operation was about four

* Frazer's Magazine, 1848.

miles in length, and was made for the transportation of ice from a small lake to the sea, in the State of Massachusetts. It was finished in 1830. In the same year, the State of South Carolina caused a railway to be commenced from Charleston to Augusta, in Georgia, the distance being 135 miles. This was finished in 1833, at the small cost of 1,336,615 dollars, which included also the expense of engines and carriages, and all necessary equipments. It was the first line of any considerable extent constructed in the United States, and it is believed to be one of the cheapest and the most successful.

A proposal has been made to construct a railroad from St. Louis, or some other place on the Mississippi river, to the Pacific Ocean, terminating either at San Francisco, in California, or at the mouth of the Columbia river, in Oregon. Its author has solicited the patronage of the national government for this prodigious work, and petitions for the grant of a tract of land, equal in extent to sixty miles in width, by 2000 miles in length. The plan was first laid before Congress in 1842. It must, however, be admitted, that a very considerable portion of the route which it is proposed to traverse, consists of desert, or of sterile and very elevated mountain districts, in which the materials for construction are scarce, and from which little support in the way of traffic could be obtained, were all preliminary difficulties overcome.

The longest continuous line of railroad in the world, and in whose construction some of the greatest natural obstacles had to be overcome, is the line which extends from the Hudson river, through the state of New York, to lake Erie. Its length is 469 miles, and it has branches of an aggregate additional length of 68 miles. Nearly its whole course is through a region of mountains. The bridges by which it is carried over the Delaware and Susquehannah rivers, and other streams, and the viaducts upon which it crosses the valleys that intercept its route, are among the noblest monuments of power and skill in engineering that have been erected. Most of these works are of heavy masonry, but one of them is a wooden bridge, 184 feet in height, and having only a single arch, the span of which is 275 feet. One of the viaducts is 1,200 feet long, and 110 feet high. The aggregate cost was 23,500,000 dollars, and the expense of construction 43,333 dollars per mile. The road was originally suggested in 1820, the Company was organized in 1832, the surveys were made in the same year, and operations were begun by granting a part of the route, in 1834. It was finished in May 1851, and opened with great ceremony during that month. The State advanced 6,000,000 dollars towards the work, and afterwards released the Company from

the obligation to pay the loan. It will thus be seen, that the execution of this undertaking occupied nineteen years, and called into requisition, not only the resources of the State, but the aid of her citizens. It may here be mentioned, that from the infancy of the American railroad system, and for ten years afterwards, it was the practice to extend to every important enterprise of that character, the assistance of the State in which it was to be carried out.

In the year 1850, the Congress passed an enactment, after a very protracted discussion, granting to the state of Illinois 2,700,000 acres of public lands, to aid in the construction of what is called the Central Railway. This donation is reckoned by the Company, to which Illinois has confided the construction of the line, to be worth 18,000,000 dollars. Since this grant has been given, innumerable applications have been made from all the new States, for cessions of land for railway purposes. Bills have been brought before Congress for this purpose, in which the proposal is made that no less than 20,000,000 acres should be ceded for these highways.*

The comparatively low cost of the construction of railways in America is the result of a variety of circumstances. In the first place, the projectors are spared all the expenses attending parliamentary contests; there are no adverse interests to be bought off; nor any exorbitant claims for land to be satisfied. The presence of a railway in any district is felt to bring with it advantages to the owners and occupiers of the soil, so great as to make it their interest to promote the undertaking by a cession of the land which is required, either as a gift, or on terms proportionate to the actual market price. How different all this is to the state of things in England, the reader will fully appreciate. Some of the railways which have been constructed in the United States have consequently been at a very low rate. Many hundred miles have been completed at an average of little more than £5000 a mile, while in this country, the permanent way would have required more than that sum. One line in Ohio is said to have cost only £1,100 a mile.

The following Table presents a comprehensive view of the condition of the railway enterprise in the several States, giving the number of miles in operation, and in construction, in each :—

* Mr. J. C. G. Kennedy.

	No.	Miles in Operation.	Miles in Construction.	Cost. Dollars.
Maine	10	283	175	8,191,693
N. Hampshire	16	463	76	14,144,755
Vermont	9	369	167	13,116,553
Massachusetts	37	1,153	67	51,384,572
Rhode Island	1	50	—	2,614,434
Connecticut	13	570	64	18,198,599
New York	44	1,946	946	67,683,155
New Jersey	10	290	40	7,445,000
Pennsylvania	50	1,323	535	42,662,918
Delaware	1	16	—	600,000
Maryland	3	355	172	14,220,503
Virginia	16	485	735	8,930,421
North Carolina	3	349	223	4,100,000
South Carolina	7	383	403	8,703,678
Georgia	13	804	181	15,100,080
Florida	2	54	—	250,000
Alabama	7	135	955	1,936,208
Mississippi	4	100	518	1,770,000
Louisiana	7	117	25	1,131,000
Texas	1	—	72	———
Tenessee	7	134	558	2,800,000
Kentucky	6	93	446	1,751,226
Ohio	26	890	1,481	17,066,661
Michigan	4	484	—	8,656,340
Indiana	20	538	1,117	9,690,000
Illinois	14	271	1,606	5,100,000
Missouri	2	—	249	———
Iowa	1	—	180	———
Wisconsin	2	20	236	400,000
Total	336	11,565	11,228	335,180,848

Mr. J. C. G. Kennedy, of the Census-office, Washington, who has collected many interesting statistics in reference to the railroads of the United States, says that there never existed greater activity in the making of new lines than at the present time. Many of the routes projected have superseded plans for canals and turnpike roads. Accordingly, these works of public improvement are not prosecuted with the same order and energy as formerly, although much activity exists in the construction of plank-roads. The labour and

capital which they would require are absorbed in the numerous and colossal schemes of railway formation. Since 1848 the length of line opened for traffic has nearly doubled, and there is reason to believe that the increase in the length of road brought into use will not be less rapid during the next period of four years. By 1860 it is anticipated that the territory of the United States will be traversed by at least 30,000 miles of railroad.

The rate of travelling on the American railways is not so great as in England. The ordinary velocity of passsenger-trains is twenty miles an hour, but on some routes as great a speed as twenty-eight or thirty miles is commonly attained. Express trains, on important occasions, frequently clear forty-five miles an hour; and it is stated that, on the road between New York and Albany, the regular rate of passenger-trains is forty miles an hour.

The rough and inexpensive character of the railways of the United States, at present places their management on an entirely different footing to that on which it is in this country. An amusing illustration of this is furnished by a writer who travelled on the line from Baltimore to Washington. The train had proceeded the greatest part of the journey smoothly enough, but when within about ten miles of the place of its destination, a violent jolt apprised the passengers that they had run against something, but it was not sufficiently formidable to occasion a sudden halt, or any injury to the carriages. The engine-driver, however, gradually slackened speed; and, on the stoppage of the train, it was discovered that the occasion of the accident was a cow that had trespassed on the line. "Sure out," said the driver, as soon as he had satisfied his curiosity. "You seem familiar with such accidents," I observed; "are they frequent?" "Now and then of a night," said he; "we do run agin somethin' of the kind, but they ginirally manage to get the worst on 't." "But do they never throw you off the rail?" I inquired. "They seem to take a pleasure in doin' it when they find us without the cow-ketcher," he replied. On walking to the front of the engine, I observed that the cow-ketcher was utterly unprotected, as American railways are, either by fences or police; the presence of this device is a very necessary precaution in the case of all night-trains. It is appended to the front of the locomotive, and consists of a strong iron grating, turned up a little at the projecting points, which is made to trail along the line a few inches from the rails. It is by no means uncommon, on arriving at the station, to find a sheep or a hog dead or dying in it. A cow or a horse is too formidable an obstacle to be run against without being

observed. On this occasion the unfortunate animal was lifted off the rail on which it had been lying, but its body was frightfully lacerated. The driver now proceeded, with the help of the stoker and some others, to drag the carcass off the line, and deposit it on one side. "Might they not as well take it into Washington, now?" I observed to one of the bystanders. "I suppose they would," he replied, "but that they want to leave room for the next." A remark which enabled me certainly to resume my place with a very comfortable feeling of security.*

The appearance of American railways is very different from that of those in Britain. To select a level district of country, and to lay down wooden rails on roughly-hewn sleepers, seems all that is necessary in some parts to make a line. Except where a branch-road joins the main, there is usually but one track of rails, so that the road is very narrow, and the view, as the traveller passes through interminable forests, is frequently by no means extensive. "Mile after mile," says Mr. Dickens, "of stunted trees: some hewn down by the axe, some blown down by the wind, some half fallen and resting on their neighbours, some mere logs half hidden in the swamp, others moulded away to spongy chips. The very soil of the earth is made up of minute fragments such as these; each pool of stagnant water has its crust of vegetable rottenness; on every side there are the boughs, and trunks, and stumps of trees, in every possible stage of decay, decomposition, and neglect. Now you emerge for a few brief minutes on an open country, glittering with some bright lake or pool, broad as many an English river, but so small here that it scarcely has a name; now catch hasty glimpses of a distant town, with its clean, white houses, and their cool piazzas, its prim New England church and school-house; when, whir-r-r-r! almost before you have seen them, comes the same dark scene: the stunted trees, the stumps, the logs, the stagnant water—all so like the last, that you seem to have been transported back again by magic." The Indians, who were formerly the tenants of these wild solitudes, have disappeared, and they are now occupied by wild animals, to whom the rushing of the steam, the shriek of the whistle, and the roar of the passing train, must be sufficiently alarming. "What music," says Dr. Dixon, "for the forest is a railroad train! How fine and perfect the harmony between the singing of birds, the leap of squirrels, the bounding of the hind, the stag, the deer, and all the other forms of life and motion peculiar to the wilderness; and

* The Western World.

the smoke, ashes, dirt, creaking, bellowing of a huge train, laden with human, and all other kinds of lumber! We dashed along through these forest scenes, indifferent as to the sentiment of concord, the 'eternal laws and fitness of things,' and matters of that sort, notwithstanding; intent only upon our mission of progress, though it should oblige us to cut down all the trees in the universe, disturb the repose of Nature in her lair, and quench the lights of heaven by the smoke of our civilizing chimneys."

The monotony of proceeding through such scenery is only varied by the stoppage of the train at stations in the woods, where we are assured that the wild impossibility of any body having the smallest reason to get out, is only to be equalled by the apparently desperate hopelessness of there being any body to get in. On, still on, it advances again, traversing the turnpike-roads without any hesitation, where there are no gates, policemen, nor signals—nothing but a rough wooden arch, on which is painted the important "Notice.—When the bell rings, look out for the locomotive."

THE WATER CRANE.

CHAPTER XIV.

THE ELECTRIC TELEGRAPH.

Fire Beacons—The Semaphore—First Idea of Application of Electricity—Messrs. Wheatstone and Cooke—Their Experiments—Description of their Patent—Apparatus employed in the Construction of the Electric Telegraph—The Battery—The "Electric Fluid"—The Wires, and Mode of Fixing them—Proposal to attach the Wires to Trees—A Negro Explanation—Effects of Thunder Storms on the Wires—Use of the Telegraph in Working a Railway—The Idea that Birds are injured by standing on the Wires shown to be a Fallacy—Use of Telegraph in regulating Time—Anticipations.

THE importance of means of rapid and efficient communication between distant places is sufficiently obvious, and was recognised at a very early period. The simplest and most significant of these were beacon-fires, by lighting which, some intelligence, whether for good or evil, might be communicated over an entire country in a comparatively limited space of time. Illustrations of the use of fire signals are abundant. Macaulay alludes to them in his *Armada*.

> "Forthwith a guard at every gun was placed along the wall;
> The beacon blazed upon the roof of Edgecumbe's lofty hall.
> * * * *
> From Eddystone to Berwick bounds, from Lynn to Milford Bay,
> That time of slumber was as bright and busy as the day;
> For swift to east, and swift to west, the ghastly war-flame spread,
> High on St. Michael's Mount it shone: it shone on Beachy Head.
> Far on the deep the Spaniard saw, along each southern shire,
> Cape beyond cape, in endless range, those twinkling points of fire."

Reference is also made to this means of communication in the "Lay of the Last Minstrel," where the approach of the English from the border stations along "height, and hill, and cliffe" is announced:—

> Till high Dunedin the blazes saw,
> From Soltra and Dumpender Law;
> And Lothian heard the regent's order,
> That all should boun them for the border."

In a note illustrative of this description, Sir Walter refers to an enactment of the Scottish Parliament, in 1455, which directs that one bale, or faggot, shall be the notice of the "approach" of the English in any manner; two bales, that they are "coming indeed;" and four bales blazing beside each other, to say that are "coming in great force."

Various means were employed for the despatch of intelligence by more systematic agency. The Admiralty transmitted a great number of their orders by the semaphore. This was an apparatus provided with arms, boards, fans, or shutters, which by means of shutters could be placed in any desired position in relation to one another, and to the person viewing them. The semaphore establishments were situated on eminences, in order that they might be seen at a distance, while the attendants were supplied with all the necessary facilities for deciphering the signals as fast as they were transmitted. These means of communication are worthy of notice here, as we shall find, that though the Electric Telegraph is a most important agent in the management of a railway; yet that the semaphore system is preserved in both its forms in the signal apparatus of our lines.

The great efficiency which the Electric Telegraph system has attained, is mainly due to the improvements of Messrs. Wheatstone and Cooke. Mr. Cooke, being in Germany, was invited by Professor Moencke, of Heidelberg, to witness some experiments with a simple apparatus, intended to illustrate the possibility of giving signals by electricity. The impressions then produced upon his mind, were of such a nature, that he devoted himself from that hour to the furtherance of his plan; while he was so aided by his native energy, and ingenuity of mind, that within three weeks of his first receiving the idea, he had constructed, at Frankfort, two galvanometer telegraphs, capable of giving twenty-six signals; added to which was his invention of the detector, by which injuries to the wires are readily traced, and the alarum, to give notice at one end of the telegraph that something is to be communicated at the other. Returning to England, about six weeks after, he occupied the following year in constructing a variety of instruments, and exerting himself to introduce his telegraph on the Liverpool and Manchester Railway. In 1837, he joined Professor Wheatstone in his arrangements, that gentleman having been for some years employed in endeavouring to transmit signals, both by sound and electricity. From that time their operations were carried forward together, and they entered into partnership as proprietors of the patent under which the telegraph is worked.

The positions occupied by these two distinguished individuals, in

reference to electric discoveries, as connected with the purposes of communication, have been well expressed in the words of Sir M. I. Brunel. "While Mr. Cooke is entitled to stand alone, as the gentleman to whom this country is indebted for having practically introduced and carried out the electric telegraph, as an useful undertaking, and Professor Wheatstone is acknowledged as the scientific man whose profound and successful researches have already prepared the public to receive it as a project capable of practical application; it is to the united labours of two gentlemen, so well qualified for mutual assistance, that we must attribute the rapid progress which this important invention has made since they were associated."

In this patent, for which application was made in 1837, the principal points of novelty were the use of a much smaller number of needles to denote all the required signals; the employment of the temporary magnetism excited in the current in soft iron to ring an alarum, by means of suitable machinery; and the reciprocal arrangement by which the invention was made practically available for a long line of communication. The instrument shown in the drawings which were annexed to their specification, was applied on the Great Western Railway, shortly after the date of the patent, and contained five needles, arranged with their axes in a horizontal line. The needles were made to hang vertically, by the addition to one end of the increased weight; and each coil was connected with a long conducting wire at one end, being united at the other with a common rod of metal, which joined together the similar ends of all the coils. The transmission of the electric current took place from the opposite ends of the wires, through two of them at once; that is to say, one of the wires, of which one key was pressed down, served to convey the current from one pole of the battery to the distant instrument, while it returned, by the rod of metal connecting the coils and the second wire, to the battery again. Two needles were in this manner deflected at once; and it will be obvious that the current would pass in opposite directions around their coils, and consequently that their deflections must be in contrary directions. The needles would therefore converge, either above or below their lines of centres, as one or other of the pair of keys belonging to each wire was depressed. Fixed stops were so placed on each side of the needles as to limit their motion, and when resting against them, the needles were parallel to two converging lines, at the point of intersection of which a letter was placed. This was the signal indicated by the movement of the needles. In a similar manner, as lines were drawn diverging from the centre of each axis, mutually crossing one another, a

number of points of intersection were formed, at one of which was a letter or signal. As any of these letters could be indicated by the movements of the needles, any communications could be made with certainty. A plan was also under consideration, for reducing the number of wires, and thus diminishing the complexity of the scheme.

The apparatus employed in the construction of the telegraphs may be divided into the following parts:—the generator of the galvanic or electric fluid, the motive, or electro-magnetic arrangement, and the conducting wires. The battery is the motive power of the machine, occupying the same relation to it that the boiler does to the locomotive; for though it can do nothing of itself, yet its work is essential to the whole. It is the fountain of that subtile stream which is popularly known as the "electric fluid." Under the superintendence successively of Galvani, Volta, Cruikshanks, Davy, Wollaston, Roget, and others, the electric generator has reached its present perfection; while the whole has undergone great improvements in its adaptation to the purposes of electric communication by Mr. Cooke, and the gentlemen of whom we shall have to speak. Mr. Cooke found that, while travelling, great inconvenience arose from the spilling of the acid solution used in Smee's batteries, and from this he was led to consider whether the substitution of fine, white sparkling sand, saturated with the diluted acid, would not obviate this difficulty. Experiments having confirmed the truth of the supposition, the change was effected, and it was subsequently found so advantageous, that the same method was tried in the permanent batteries, and the issue was equally satisfactory. The generator now usually employed resembles in its principal features the one known as Wollaston's trough, and it is so arranged, that the series of plates of copper and amalgamated zinc, provided for the evolution of the galvanic fluid, admit of being placed in a corresponding series of cells, filled with well-washed and dry sand. To put these instruments into action, it is only necessary slightly to moisten the sand with diluted sulphuric acid; and they are stated to be very constant in their action, being found to work during periods varying from two to five months, with only small occasional additions of the acid solution to supply the waste produced by evaporation and chemical absorption. The sand, too, appears to check injurious rapidity of action, and, at the same time, to prevent the separation of the sulphate of copper and zinc, formerly held suspended in the fluid.

The property possessed by the wires of rendering iron magnetic when subject to the galvanic currents, may be illustrated in a simple

manner, by passing copper wire a few times round a glass tube, so as to form a coil, like a bell-spring, taking care that the turns of the wire are nowhere in contact; if the ends of the coil are then connected with the poles of the battery, and a small sewing needle is placed in the glass tube, it will be immediately drawn to the centre, and, if examined, will be found to be permanently magnetic. If, on the other hand, a piece of soft iron wire had been introduced into the glass tube in the place of the steel needle, it would be found to be magnetic only so long as it remained under the influence of the exterior coil of wire,—proving that it is to the magnetising property of the electric current, under a certain form of arrangement, that we owe our motive power; and it is to the varied motions or vibrations of the needles on the face of the dial-plate, produced by this agent, that a form of alphabet has been adopted, by means of which we are enabled to communicate with a person at any distance from us. Till the year 1840, the wires were covered with cotton, and insulated by coating them with shell-lac, resin, or pitch; and they were laid down in pipes of wood or iron. It was, however, subsequently found that, under existing circumstances, the advantages would be equal, and the expense greatly diminished, if the wires were suspended on poles in the open air. By the adoption of this plan, superior isolation, greater permanency, and increased facility of repair would result; and while the cost of the original plan was estimated at £300 per mile, it is reduced, in the improved system, to £150. The ordinary method of proceeding, in the establishment of the telegraph, has been, first, to fix firmly in the ground, at every five or six hundred yards, strong posts of timber, sixteen or eighteen feet high, eight inches square at bottom, and tapering off to six or seven inches at the top, fixed into stout sills. A coil of iron wire is then placed upon a reel, carried on a hand-barrow, and one end being attached to the winder at one draw-post, the wire is extended to the adjoining draw-post, and fixed to a winding apparatus there; and then, by turning the pin of a ratchet-wheel with a proper key, the wire is tightened, so that the greatest accuracy may be attained in drawing the wire, until they are as nearly as possible parallel to each other.

At each quarter of a mile a stouter post is placed, to bear the winding or straining apparatus. This consists of a simple winding-wheel, connected with a ratchet-wheel and clink, to prevent its recoil after the wire has been once put up. The intermediate posts or standards merely support the wire, having no influence on their tension—this being performed by the winding apparatus. When,

however, the wires are placed in tubes, as is sometimes the case in passing through the streets of a city or elsewhere, instruments called "detectors" are placed at about a quarter of a mile apart, to indicate the state of the wire, and are very useful in case any accident impairs them. Thus it was found, on one occasion, that the wire of the Admiralty telegraph, between London and Nine Elms, had received an injury, which the detector showed to be in the neighbourhood of the Waterloo-road; and it was repaired without difficulty.

A suggestion has been offered which is worthy of notice, for the employment of supporters to the electric wires, instead of the posts which are now used, and which are so liable to decay. Mr. Summers, of Norwood, has proposed that young trees should be planted where the nature of the soil would allow it, the first cost of which would not, probably, be greater than that now incurred, through which the wires might be carried, protected by tubes, extending a few inches beyond the bark, which would prevent the growing wood closing them up. If this should in any way interfere with the growth of the tree, which is not anticipated, the wires might be attached to a limb. When the proposal was made to the secretary of the Electric Telegraph Company, he replied that the plan was undoubtedly an excellent one, but as his Company were only lessees, the gain would all be on the side of the railway on whose ground they might run.

While alluding to the posts by which the wires of our telegraphs are supported, we are reminded of an amusing explanation of the telegraph, which was once given by a negro, and which may be fairly regarded as quite as correct and quite as philosophical as many attempts of the kind which have been made by his pale brethren. The scene is laid at Lowell, where the following conversation between two "sprigs of ebony" came off. "Look a-hea, Jake," said Sambo, his eyes dilating, and his rows of shining teeth protruding like a regiment of pearls,—"Look a-hea, Jake; what you call dem ar?" 'What ar?" rejoined Jake. "Dem ar I is pintin' to?" "Dem ar is postes," said Jake. "What!" said Sambo, scratching his head; "dem ar postes wid de glass?" "Yes, de same identical," returned Jake. "Ah! but you sees dem ar horzontal wires." "Well," observed Jake, "de postes supports de wires." "Gosh! I takes you, nigger," ejaculated Sambo, clapping his sides, and both setting up a loud yah, yah. "But what's de wires for?" said Sambo, after a pause. "De wires!" replied Jake, completely staggered for a moment, and at a nonplus for a reply to the philosophic

curiosity of brother Sambo; but suddenly lighting up with more than negro fire, he said, "*De wires is for to keep de postes up!*"

The insulation of the wires forms an important feature of the improvements which Messrs. Brett and Little have introduced into our Telegraph system. It is obvious, that if care be not taken to prevent communication with the post to which the wire is attached, an effect very likely to occur from the deposition of moisture, great difficulties would arise. To obviate this, a thick strong glass is contrived, not very unlike an inverted tulip, only that the side is straight, instead of having a curled and thin lip. This is placed, mouth downwards, upon an iron bracket nailed to the post; the connexion between the glass and iron being made in the upper and inner part of the bell by a suitable cement, and through the upper and outer crown of the bell the wire is threaded. By this contrivance, however wet the wire may be, it is impossible the moisture can be the medium of communication with the ground, for the wet falling on the glass, drips off from its lower edge, and cannot even render the interior damp, much less communicate with the iron supporter. This contrivance is very superior to the imperfect bit of stonework which was formerly employed. The wires are now usually covered with zinc to prevent corrosion.

The effect produced by the electricity of the atmosphere upon the telegraph are remarkable. These phenomena were very distinctly observed on one occasion between New York and Baltimore. Three thunder-storms, thirty or sixty miles from each other, were all "going east" on the route of the telegraph at the same time, and every discharge of the fluid was duly recorded by the lightning itself in the telegraph office at Jersey city, Philadelphia, Wilmington, or Baltimore. The wires became altogether unmanageable, and the operators being obliged to give way to these mighty message-senders, withdrew the batteries used for writing, and the clouds had the field to themselves. The letters of Morse's telegraphic alphabet to which this natural lightning seemed most partial were L and T, but occasionally it went at the numerals, and dashed off L's, 50's, 55's, 500's, and 5000's in its own rapid style. It is also affirmed, that when two or more thunder-clouds are in the same vicinity, and discharge their electricity at one another, or receive the fluid from the earth, and return it again, the effect on the telegraphic wires is to produce a strange and original language, "which," some have said, "may yet be made intelligible!" In fact, each kind of lightning *speaks* for itself, and writes what it says.

Of the value of the telegraph in its relation to the working of a railway, a remarkable instance is furnished by Elihu Burritt, once best known as "the learned blacksmith," now best characterized as the earnest and laborious advocate of peace, and of the intercommunion of nations. "During a storm and violent gale, a long railway bridge across the Connecticut, between Hartfield and Springfield, was lifted up by the wind, and thrown into the river beneath, two hundred yards in breadth, which a powerful current at the time swelled to a dreadful height by an unusual flood of rain. The line here is crossed by a bridge fifty feet above the river, after an abrupt curve has been passed. But the passengers within congratulated themselves on their comfortable situations, thinking of the blessed homes and the firesides which they soon expected to reach. On came the train, the engine blowing off its head of steam, breasting its way nobly against the gale, which almost threatened to check its progress, the hot iron hissing furiously in the pelting rain. No one knew or even suspected that the bridge was gone. For two years, by day and by night, the trains had passed and re-passed, until safety had obliterated the thought of even the possibility of danger; but no bridge was there to receive them, and the long train, with its precious freight, rushed on towards the precipice of destruction. It was not customary to stop at this place, excepting to check the speed for the landing of passengers; but the people there had learned, through the instrumentality of the telegraph, the loss of the bridge, and kept a sharp look-out for the approaching train. It came; the word is given, and they are safe. Every heart leapt from its place, and the head swam giddily with fear as the thought came of that fearful leap in the dark; and long will the passengers remember that dreadful road, and the friendly yet fearful cry of 'THE BRIDGE IS GONE!'"

A mistake may here be corrected, into which many have fallen. It has been stated, that sparrows and other small birds which happen to perch on the electric wires, "are destined, ever and anon, to suffer severe shocks of electricity, the effect of which is (though we never witnessed the phenomenon), that they drop down, not dead, but half-dead, with amazement and terror. The shock, if severe enough, will destroy them. Perhaps, by transmitting through the telegraphic wire a very powerful charge, the unhappy sparrows along the whole line, from London to Yarmouth, might be cut off." From the fact thus assumed, an arithmetical calculation followed, that as it is not uncommon or extraordinary to see at least a hundred of these feathered depredators on a single mile of wire, and the length of the whole line alluded to is 146 miles, a shock strong enough to destroy

sparrow-life would, according to these *data*, cut off from the land of the living, at one fell and fatal swoop, no fewer than 14,600 of these "pernicious little creatures," and a thousand miles of wire would, in like manner, and with the same conditions, be the death of 100,000. But we must give the remainder of the argument in the words of the writer. "Even supposing that death does not ensue, yet how miserable will be the state of these little animals, when the whole island is covered with a veritable network of telegraphic wires! Fatal twigs these for tiny feet! The whole family of sparrows will be paralysed. The fowls of the air will be electrified. People, as they talk with each other, and whisper to each other in unheard communion, at the distance of a thousand miles, will be causing serious inconvenience to the feathered race. If Lord Palmerston's dream should be realized, and London should begin in a few years to commune by telegraph with Calcutta, how terrible the visitation to our fellow-bipeds with feathers! Each word—each letter will be a shock. To us it may be pleasing to hold intercourse with each other—to the little sufferers it will be *shocking*. We tremble to think of the consequences, and heartily recommend the case to the Society for the Prevention of Cruelty to Animals. Dog-carts sink into insignificance when compared with this wholesale palpitation—this universal twittering and consternation—among the feathered tribes. How many a sweet song will be interrupted—how many a little throat silenced—very suddenly, indeed, when this mischievous machinery shall be brought into universal play!"*

Now all this, if we may avail ourselves of a modernised phraseology, is "a myth."

The idea that birds can be injured by the electric fluid, by merely perching upon the wires; is a mistake. In order that the bird should be acted upon by the electricity, it is essential that it should form part of a circuit, which in our system of arrangements is accomplished by the current passing from terminus to terminus, along the wires, and returning by the earth. The most delicate galvanometer may be attached to the wire along which the current proceeds, but no effect can be traced till we also connect it with the earth, and thus complete the circuit. Thus no bird can receive a shock unless it is tall enough to stand upon the ground and touch the wires; and even were such a prodigy to be formed for experimental purposes, the feathers of its head, and even the horny skin of its feet, would not act as conductors unless well wetted. Mr.

* Chambers' Edinburgh Journal.

Culley, of the Telegraph Office at Derby, mentions that, over a thousand miles of wire of which he had the inspection, he never saw any effect of the kind which some have imagined. Birds, however, are frequently found dead upon the wires, and he has seen a wing hanging on them, and on searching has discovered its owner in the grass below. The men connected with the Company have also frequently seen partridges fly across and kill themselves, not by a shock of electricity, but by striking their bodies forcibly against the wires in their flight. The same gentleman mentions that he has seen two hundred or more sand-martens on a wire whilst the instrument has been in action, sitting as contentedly as possible; and our readers have doubtless watched them thus occupying what seems to be a very favourite perch. We have availed ourselves of the opportunity of thus explaining this simple fact, as the mistake referred to has been, if it is not still, very prevalent.

One of the latest applications of the electric telegraph is at once useful and beautiful. It is a plan for distributing and correcting mean Greenwich time in London and over the country every day at noon. Every holiday-maker knows the ball which surmounts the Royal Observatory, and has watched with interest its descent as the clock gave the first stroke of noon, thereby telling the sea-going men in the river the exact state of the chronometers to which they have to trust over the pathless waters. Such a ball has been raised on a pole on the Telegraph Office, near Charing Cross, and at noon each day is to drop by electric action simultaneously with that of Greenwich, and falling on a cushion at the base of the pole, is to communicate standard time along all the telegraphic wires of the country. At the same instant the exact period of noon will be known at the most distant as well as the less remote places in the country; and it is said that all the Railway Companies have agreed to avail themselves of these means of obtaining an exact uniformity of time. By the same agency, *viâ* the submarine telegraph, communication will be maintained between the Observatories of Greenwich and Paris.

The electric telegraph is an important aid in the efficient management of railways, and as it is almost exclusively constructed on lines, a few remarks on the application and results of this discovery may not be inappropriate. The wires of the Telegraph Company now stretch from Glasgow to Dorchester, from Yarmout to Liverpool, and to about 200 principal towns in various parts of the kingdom. From a central office in Lothbury, and five branch receiving-houses in various parts of the metropolis, the wires diverge to every portion of the land, with which communication may be

momentarily effected. In the metropolis a large number of persons are thus employed, and at each of the country stations they have one, two, and even as many as ten, signal clerks, besides messengers who are skilled in manipulating and interpreting the telegraph.

The agency which has thus been developed is worthy of the age of railroads, and though of less practical value, yet it is even more extraordinary. "Give me," said a profound electrician, "but an unlimited length of wire, with a small battery, and I will girdle the world with a sentence in a few minutes." Its ultimate results all may ponder. In a few years, when the advantages of the system shall be more generally diffused, the electric telegraph will bring, as it were, the whole family of England—perhaps of man—under one roof, and into one room. The metropolis will receive intelligence from, and transmit it to, all parts of the island. For every great need the farthest extremity will state its wants, and the railway will bear the desired assistance within twenty-four hours. The island will become possessed of a nervous system, the rapidity and precision of which will be comparable only to that of the human frame; while London will be the sensorium of the acutely sensible and intelligent whole. The most northern or western district will communicate its sensations as the finger or the eye transmits its noiseless tidings to the brain. Termini a thousand miles apart, with a hundred intermediate stations, will receive, if necessary, the same announcement at the same moment. "On a few dials will appear the continual reflex of a nation's history."

APPENDIX.

A.

ABSTRACT OF THE PROCEEDINGS OF THE COMMITTEE OF THE HOUSE OF COMMONS ON THE LIVERPOOL AND MANCHESTER RAILROAD BILL. SESSION 1825.

THE first parliamentary battle for a railway was fought in 1825, when the proposal to construct a line between Liverpool and Manchester was considered by a Committee of the House of Commons. It is true that the sanction of Parliament had been previously given to other lines, but they were chiefly unimportant in extent, and did not encounter much opposition. But in 1825, the great struggle was between the railway and the canal, and the interest at stake was the continued progress of the great towns of Liverpool and Manchester. In the text of the present work, reference has been made to the proceedings of the Committee on the Bill; but it is considered that the peculiar interest attaching to these proceedings requires that in a work like this an abstract of them should be given, which could not conveniently be inserted in the text. The Report of the proceedings of that Committee will soon, if it has not already, become an important document in the history of civilization; and by the contrast, which every year is making broader and more striking, between the anticipations of the men of 1825, and the actual results, will show how great is our ignorance at any time of the power of natural forces, and how little we know of our own ability to direct these forces for the accomplishment of certain ends.

The Committee of the House of Commons to whom the Bill was referred met for the first time on Monday, March 21, 1825. The chair was occupied by General Gascoigne, who was then member for Liverpool. In our time, no member for the locality interested in or affected by a Railway Bill is allowed to be a member of the Com-

mittee by whom it is to be considered. He may attend and give such advice and assistance as his local knowledge and position may render useful, but nothing more. The other extremity of the line, the great town of Manchester, was neither represented on the Committee, nor in the House; for Manchester was then neither a borough nor a city: it had not what it has since acquired,—a Mayor, and representatives in Parliament, and a Bishop.

The Company appeared by counsel, the chief of whom were Serjeant Spankie and Mr. Adam; while arrayed against the Bill was a formidable phalanx of canal-owners, road-trustees, and landed proprietors; among whom were the trustees of the Duke of Bridgewater, the proprietors of the Mersey and Irwell Navigation, the proprietors of the Leeds and Liverpool Canal, the trustees of Barton Road, near Manchester, Sir William Gerrard, Charles Orrell, Esq., and other landed proprietors through whose property the line was intended to pass. The legal talent engaged on their side appeared overwhelming,—Mr. Alderson and Mr. Parke (both of whom have since that time been raised to the bench), Mr. Harrison, Mr. Rose, Mr. Earle, and Mr. Cullen.

The first day was entirely occupied by the opening statement of Mr. Adam on behalf of the promoters of the line.

"He began by saying that he proposed to discuss the subject in two points of view, first, with reference to the state of commercial interests; and, secondly, as connected with a more expeditious mode of conveyance. Railways are a more convenient, a more safe, a more economical, and a more certain mode of conveyance than any modes which now exist. Unless something be done to increase the facility of communication between Liverpool and Manchester, the advances now making in commercial prosperity must cease. Economy is one of the principal things on which to found the success of our commercial interests. If the Committee find, that, by the mode suggested, parties will be able to convey goods from the place of manufacture to the place of exportation at a very reduced rate, and in much less time than at present, the present measure ought to receive the sanction of the Legislature.

"The promoters of the Bill ask permission to make a railroad, for the purpose of procuring a more expeditious mode of conveyance between the towns of Liverpool and Manchester. They allege, that 'the making and maintaining of a railway or tramroad, with proper works and conveniences adjoining thereto, or connected therewith, for the passage of wagons and other carriages from or near the town of Liverpool, in the county of Lancaster, in and through the several parishes or places hereinafter mentioned, to the town of

Manchester, in the same county, will be of great advantage to the inhabitants of the said county, towns, and places, by opening an easy and expeditious communication between the two large trading towns of Liverpool and Manchester, and by affording an additional mode of transit for merchandise and other articles and matters between those places; and also to and from the neighbouring county, and will in various other respects be of public utility.'

"He would undertake to show, that the present means of transit are not sufficient in themselves. They are uncertain, attended with great risk, and with great expense. The promoters of the Bill do not desire to supersede any of the existing establishments; on the contrary, they are desirous to go hand-in-hand with them. He was bound to show, he admitted, that the proposed mode of conveyance shall be as speedy, as cheap, as safe and certain, as the other in all respects. If that is done, he should make out a case sufficient to call upon Parliament for its aid; but he would do more, he would show that they shall exceed in all those particulars.

"Manchester, and the country of which it is the centre, includes a manufacturing population of above half a million. The population of Manchester alone amounts to one hundred and sixty-five thousand. Within the last three years it has increased thirty thousand, and that, perhaps, is carrying it further back than the great commercial increase of the country requires.* Manchester is the channel of communication through which the clothiers of Yorkshire export their commodities, and the manufacturers of Sheffield send much of their hardwares, as well as a variety of other commodities. They all make use of Manchester as the centre, and require the same means of transit, as the goods manufactured in the immediate vicinity of that large and populous town. There are a great quantity of manufactured articles, the transit of which is to be provided for at Manchester to Liverpool. They require extensive means of transit, and if that be so with the articles exported, it must be exceeded by the imported articles, for the greater part of the articles manufactured in Yorkshire, and in the neighbourhood of Manchester, are far more bulky, and require much more space in their raw state, than when manufactured. With respect to the necessity of an increased facility of transit, it is observable, that if this railroad should receive the sanction of Parliament, there will be another most important article of

* The population of the boroughs alone of Manchester and Salford, according to the Census of 1851, was 401,321; and Manchester, and the great district of which it is the centre, certainly contains now a population double what it was when Mr. Adam made this speech.

transit, the conveyance of which will be much increased, namely, coal; for the supply required for so large a town as Manchester with the steam-engines, and the consumption in the town of Liverpool, will alone extend to a considerable amount, and to that extent the means of conveyance beyond that which now exists must be provided. This alone must strike the Committee with the necessity of making more suitable provision. The single article of cotton will at once show the necessity of that for which the sanction of the Legislature is asked. The Committee, perhaps, will be surprised to hear that the quantity of cotton sent from Liverpool to Manchester,

In 1824, exceeded . . .	160,000,000 lbs.
In 1815, it was	110,000,000
Increase in those years . .	50,000,000

If the progress of our commercial interests is to go on in the same ratio, the Committee will see that the increased means of transit which will be afforded by this railroad are necessary.

"Liverpool is the port of England which carries on by much the larger share of intercourse with the United States of America, with South America, with British America, with Ireland, with Africa, and it is connected with many other important branches of trade. The present population of Liverpool is in amount very nearly the same as Manchester, 164,000 people.* The number of ships that found their way into the docks of that port;—

Years.	Ships.	Difference in One Year.	Tonnage.	Difference in One Year.
1824	10,001		1,180,914	
1823	9,507	494	1,120,114	60,800
1822	8,910	597	1,010,819	109,295
Increase in 2 years,		1091		170,095†

It is not to be understood that the whole of the import in those ships finds its way direct from Liverpool to Manchester: but it will be proved hereafter most satisfactorily, that the difference between the aggregate of those goods which find their way to Manchester and those which go to other parts is so trifling, and of such little importance, as by no means to affect the reasoning. With regard to

* In 1851, it was 376,065. This, however, was the population only of the borough; if the suburbs are included, it may be estimated at about half a million.

† In 1850, the number was 20,457, and the tonnage 3,536,337.

timber, the Committee will find there has been a regular increase of the trade in that article. The following is a comparative statement for the years 1822 and 1825, ending in February in those years:—

Years.	Ships.	Countries.	Ships' Tonnage, in round numbers.
1222	307	British America	
	77	Baltic	
	384		100,000
1825	427	British America	
	182	Baltic	
	609		160,000
		Increase,	225 ships
			60,000 tons

What is the condition of the cotton trade from America? The whole of the cotton imported into Liverpool, with very little exception, finds its way to Manchester, and at present is imperfectly supplied by means of the existing canals. The amount of cotton imported in the year 1823 into Liverpool was 668,400 bags, but from America alone the quantity exceeded 400,000 bags.*

"In the year 1773, the canal of the Duke of Bridgewater and the Irwell and Mersey Navigation were in progress. The population of Manchester at that time did not amount to quite 28,000. It is a most curious fact, that in the year 1790 there did not exist one steam-engine in Manchester, though in 1824 there were above 200. So slowly did those advantages find their way among the manufacturing population of Manchester, that though at present there are 30,000 looms worked by steam, in 1814 there was not one worked in that mode. This circumstance is mentioned for the purpose of contending, that if it is found that the articles sent from Manchester to Liverpool, and the raw articles from Liverpool to Manchester, are so greatly increased, and that the facilities of conveying those articles are not greater in point of capacity than at that time, the promoters of this Bill are entitled to a decision in their favour.

"Some idea of the demand for the means of conveyance may be formed, when, in addition to these facts, attention is called to the quantity of articles that must be supplied for the daily consumption of the inhabitants, exclusive of that of the manufactories; and when it is considered, that wine and tea, and other articles, must be sent from Manchester into the interior, to meet the wants of this enor-

* The import is now about treble what it was in 1823.

mous and fast increasing population. The transit between Liverpool and Manchester does not fall short of 1200 tons every day; and there has been in the last year an increase of 1000 tons a week beyond that which existed the year preceding. Therefore if 1200 tons be the quantity that now passes every day between those two places, we have reason to believe that an enormous increase of facility of transit will be required.

"For the passage of bulky articles, there exist three means: the Mersey and Irwell Navigation, the Duke of Bridgewater's Canal (a work which does that nobleman immortal honour), and the Leeds and Liverpool Canal. The original object of the last was to communicate between Liverpool and Leeds; and it is only a few years since that it was made the means of communication between Liverpool and Manchester; but the expenses, and the circumstances under which it is carried on, render it hardly possible that any persons can avail themselves of that medium of communication. Those are the means, and those only, by which persons can send their goods from Liverpool to Manchester.

"It will be shown, that both the manufacturer who wants the article to work up, and those who receive it for the purposes of general commerce, suffer a great loss and inconvenience through want of the means to send their goods up to Manchester, and bring them back again. It will be shown, that those who have goods to send, have them materially delayed. The carriers keep a book, and they say, "You had your turn last week, you must wait your time."

"If it shall be shown, that large manufacturers have actually suspended their operations because they have not had the means of carrying them on; if it is shown that large sums have been lost in consequence of the non-arrival of those goods, will you say, for the sake of any person, however meritorious or however respectable, that you will allow things to remain in that situation? It will be shown that it has taken lónger time to pass goods from Liverpool to Manchester, than to bring them over from America to Liverpool. It will be shown, that what is now stated takes place not once occasionally, but often; that goods have taken twenty-one days in coming from America to Liverpool, and that they have stayed upon the wharves before they could get the means of conveyance to Manchester for more than six weeks.

"It will be shown, that, on the 28th October, 1824, application was made by a gentleman of the name of Ashton, for the transit of forty bags of cotton; that twenty-two days elapsed between the application and their arrival at Manchester. On the very next day, another

house, of the firm of Smith and Rawson, applied for the means of conveyance, and they had to wait twenty-four days. Vandry and Company, upon the 30th October, were kept eighteen days before they could get the goods passed; and in November ten bags were passed in ten days.

"Persons who have had goods to send have submitted to send them by common carts on the turnpike roads rather than suffer the delay to which they would be exposed by the other existing means of conveyance. It will be proved that, in one case, there was application made for the transit of 1000 bags of Egyptian cotton, which occupied more bulk, and it did not answer their purpose to take it so well as the other. During one whole week they passed but thirty bags—for four or five days they passed none—although the person to whom it was addressed required 100 bags a week to carry on his manufacturing operations. You will be shown that it took six weeks before this lot, which he desired to have forwarded under the circumstances stated, found its way to Manchester to be worked out. Another person you will find was actually obliged to buy cotton in Manchester in consequence of the delay, not intentionally, but on account of the inadequate means they had of sending them for want of facility of conveyance. Spinners have been obliged to stop their employment, and persons have lost advantageous bargains. I will show you that bargains have been repeatedly rejected, because the parties making them could not execute them; the delay not being with them, but with the Canal Companies. Instances of delays will be proved till the Committee tell us to stop.

"Timber has been obliged to be deposited on the shores, until the owners have been fined by the Corporation of Liverpool for leaving it there beyond the time which is allowed by Act of Parliament, because means could not be furnished to forward it into the interior of the country. Instances, and repeated instances, will be shown in which corn has been under the necessity of being landed and warehoused, because it could not be sent on.

"Liverpool is in an open estuary, liable to the operation of strong tides, and most violent winds. In point of fact, its navigation is a sea voyage, and a sea voyage under the most serious and inconvenient circumstances; for the course of the River Mersey is so shallow, and the channel of the river so narrow, that not above three hours out of twelve can it be navigated at all. You have to thread the mazes of its sands and shallows, and at all times it requires great skill to navigate it. It will be proved to you that the vessels must arrive at Runcorn, where the Duke of Bridgewater's Canal and the other

canal enter the Mersey, at high water, and that they must therefore leave Liverpool some three hours before the rise of the tide; and, on the other hand, in order to get over the shoals that would obstruct their passage, they must go off at high tide, and if they miss that, they lose their voyage. This navigation is attended with danger. No longer ago than the month of November last, two vessels, with all their crews, were lost in their passage from Runcorn to Liverpool, and three were stranded; that is by no means an unfrequent occurrence.

"The New Quay Company are in possession of seventeen flats, which navigate the Mersey and find their way in due time to Manchester and back. Between the month of June and December last, those seventeen flats performed per week eighteen trips, so that there was a trip per week, and one over to divide among the eighteen. A vessel requires a week to make a trip from Liverpool to Manchester, unload its cargo, and take in another, and find its way back again. Winds and strong tides prevail in this estuary as well as in other places exposed as it is. The south-east wind sets in there with extreme violence, and it is a navigation not to be despised even by the most experienced seaman.

"But perhaps it will be said that the navigation shall be made better, and additional means afforded by which greater facilities will be acquired; and it may be suggested that they will employ steam-boats, and thereby get the better of winds and tides, and produce a more regular and more frequent communication. The first observation this leads to is this, if that is a proper recipe for the inconvenience alluded to, it is very much to be wondered at, that those who have the charge of the establishments should not have adopted it before, for it can hardly be said that they set the public at defiance. But for his part he was obliged to confess that he doubted very much whether it was a sufficient excuse; and he was warranted in saying, that as soon as the pressure of the railroad is taken off, all their exertions will cease, for that which has been done during the past will be continued to be done for the future, under the same circumstances.

"With respect to canals, sometimes they have to struggle with frosts. So long ago only as 1802 or 1803 this took place, and twice within a still later period, and of course they are liable to drought. It may be said there are not so many boats on the canals as they could work. He doubted that—for the more boats the more profits, and their interest he was sure had not been overlooked; but you can never send goods upon those canals where they have to pass through

a vast number of locks, at which there must be a proportionate quantity of delay, with the same celerity as by the mode proposed—viz. railroads. The shortest line by the canals is fifty miles at least. It is liable to the general impediments of canals; besides the difficulties of a sea communication in part. Although the distance is not above fifty miles, it will be shown that the average time in performing the voyage from Liverpool to Manchester is thirty-one hours. It may be shown that it has sometimes been not more than twelve: that a vessel has been out and home in twenty-four hours. If we are to take it that way, we must apply in aid the fact of the goods that have been detained for weeks and months; but the average is about thirty-six hours. If they perform the voyage in thirty-six hours, he would engage to show that his railroad should perform the same distance in six hours.

"The distance between Liverpool and Manchester by the railroad is thirty-two miles and a half, instead of fifty. Since 1759, railroads have been known to a certain extent; but within the last ten years they have been in use, under circumstances not to be compared with those under which we stand, with great and considerable success. You will find in the neighbourhood of Newcastle one instance of a colliery at Hetton, in which a railroad has been in existence long enough to show the application and safety of steam to the conveyance of heavy articles. The distance from the colliery of Hetton to the river Wear is about seven miles, and the quantity of weight carried is about sixty tons; the rate that the railroad is travelled upon is about four and a half miles. It is a railroad under most unfavourable circumstances: in the first place, the railroad itself is not very perfect; but the machinery of the vehicles in which the coals are carried is still less perfect than the road, and yet you find that they work it to the extent of sixty tons. None of the tremendous consequences have ensued from the use of steam in land-carriage that have been stated. The horses have not started, nor the cows ceased to give their milk, nor have ladies miscarried at the sight of these things going forward at the rate of four and a half miles an hour. But besides the Hetton Railroad, there is another, viz. the Killingworth Railroad, which has existed for ten or eleven years, and which is in the neighbourhood of Newcastle, and that establishment has existed without any reason to doubt its efficacy, without any objection, and with the greatest possible advantage. That railroad runs over an undulating surface. But the proposed Liverpool and Manchester Railroad continues scarcely with any rise,—so little that it is scarcely worth noticing. It is so far from

sudden rises, that it will not be necessary to have one fixed steam-engine on the whole line. Locomotive engines we shall have, and horses we may employ if we think fit, but we shall not have to employ one single fixed steam-engine from one end of the line to the other.

"With regard to the liability to accidents by locomotive steam-engines, it is said that, inasmuch as it must be a high-pressure engine, it is not a safe means of employing the force of steam. The answer is, that the assertion is not founded in fact. It is true that we shall be obliged to employ high-pressure engines, that is, engines where the steam will not be condensed; but so far from their being that description of engine which will increase the quantity of danger, you will find that the pressure is so little more than upon those that are called low-pressure engines, as scarcely to be worth notice. The petition lately presented to the House from two ladies, relates a fact that he was not ignorant of; but you will find that the accidents have arisen from one of two causes, either from gross negligence, which would have produced the same accident even with other engines, or that the boilers have been made of improper materials: they have been made of cast-iron; for in the case of a wrought-iron boiler bursting, the opening is gradual, and the steam gradually escapes, and thus it does away with all danger.

"Parliament has recently passed an Act in which locomotive engines of the kind I am speaking of have been adopted. I believe in the county of Durham there is one for the extent of twenty or twenty-three miles. He would not say one word as to the details of the experiments that have been tried; but he was fully satisfied that locomotive engines could supply force to drive a carriage at the rate of five or six miles an hour. I say that those laboured petitions, and the opposition that is to be made, plainly show that they know that if steam was applied to the transit of goods between Liverpool and Manchester, it will produce the most beneficial results.

"The promoters of the Bill are certainly bound to show that they will serve the public as cheap as the present carriers by water. The charges made upon the Duke of Bridgewater's Canal in respect to the tonnage taken by them in the shape of tolls, as the owners of the canals, were 5*s*. 2*d*., but they have been reduced to 3*s*. 8*d*. The Old River toll stands at 3*s*. 4*d*. per ton. Now, both the Duke of Bridgewater's trustees and the proprietors of the Old River are not only the proprietors of the canals, but they are also working carriers. Of course they enter into a competition with other persons under the most favourable circumstances. Not only are they owners of

the canals, but, by the most judicious means and prudent foresight, they have become owners of the warehouses at Manchester; and so as to make it utterly hopeless to enter into competition with them. The trustees of the Duke of Bridgewater's Canal, and the Old River Company, at the same moment and upon the same grounds, thought proper to make a rise; and they did so to an extent which they could not justify; for after a certain period they dropped it. If this Bill be not passed, and a competition by that means established, there is no saying that the trustees of the Duke of Bridgewater's Canal, and the proprietors of the Mersey and Irwell Navigation, may not coalesce and raise their tolls again to 5*s*. 2*d*. There are by-carriers on these canals, but the tolls which are exacted, and the impediments that are thrown in the way, by the owners of the canals, who are carriers as well as owners, and who own the warehouses, are such that those by-carriers can get no profit. Formerly they usually charged 18*s*. per ton. That is not the case now in timber, cotton, and corn. They charge at the rate of 15*s*. per ton for cotton, 10*s*. for corn, and 8*s*. 6*d*. for timber, which, we contend, and we shall submit to you upon evidence, is much too high, and more than the trade of the country can bear. We engage to carry on our trade at from twenty to thirty per cent. less than the average charge made by the Old Quay Company, or the Duke of Bridgewater's trustees, spreading over a period of ten years. Now, sir, having stated these observations, let us see by whom these measures are opposed. There is no petition from any large body of manufacturers, that there will be a prejudice to those who are interested in the transit of goods wanted by the manufacturers, which we look to more particularly than to the transit of articles of luxury. At present, I know there are most respectable parties petitioning against the Bill; the Company of the Old River, and the trustees of the Duke of Bridgewater, and the Leeds and Liverpool Canal Company, who say their interests will be affected by the experiment. Do they represent any portion of the public? Do they speak for anybody's purpose but their own? It may have been quite right that they should enjoy the preference they had acquired. But if it is shown that the period has arrived when there ought to be increased means of conveyance, and that the present monopoly should continue no longer, is it an answer to say, that the profits should continue to flow into the pockets they formerly did? It may be said, however, that they have embarked large capitals. It is fit, then, upon every principle, that they should have a fair return; that persons should receive a sufficient compensation. But if my learned

friends are not prepared to say that the trustees and the proprietors of the canals have not received a most adequate and liberal return, it comes to nothing. We know the quantity of their tonnage, and we know the charge; so it is easy to make a calculation. We are the persons who complain. No doubt the complainants, on the other side, are as much entitled to respect as any persons in his Majesty's dominions. What is the case of Lord Wilton, Lord Derby, and Lord Sefton? They state that they are large proprietors of lands. Do they state that those smoking engines, which are said to be nuisances according to law, affect their dwellings, as if the promoters of the Bill were going to bring a railroad under their parlour windows, and deprive them of the enjoyment of their own firesides? This railroad will not pass within two miles of my Lord Derby's house, nor near to the residence of Lord Wilton, nor near to my Lord Sefton. Their houses are not within sight, or within smell, or within hearing. It must be imagination that could induce those noble persons to make any opposition, so far as they are personally concerned. But when we consider their property, would it not be greatly advantageous to them? Will not their tenants be able to send their articles to market, and get back manure, at a price which beggars all discussion? It may be said, in some parts the cutting will be deep, and will impede the passage from one part of those noble lords' estates to another; but you may walk across the railroad, though you cannot walk across the canals; so that he could not see upon what footing you can say that it ought not to receive the sanction of Parliament, if it is to be for the advantage of the community, or that their property will be deteriorated; though it must be attended with the same advantage to them as to the proprietors of other land. Now, the honourable members who have attended up-stairs, know that with respect to the concurrence of those who assent, as compared with those who dissent, it scarcely amounts to one-third. The number of owners who dissent are but 86, the number who do not dissent are 249; the number of occupiers who dissent are 128, and the number who do not dissent are 368; the number of assents of owners without neuters are 152, against it 86; of occupiers, the assents 302 without neuters, and 128 dissents. Upon the whole, you will find that the number of assents cover a larger portion of the extent than is covered by the dissents, notwithstanding the large and preponderating property belonging to the noble individuals. This railroad will pass through a coal country that is not far from the town of Liverpool, or the town of Manchester; and of course near to the places lying between those two. Is it not a matter of consideration,

that this necessary of life should be conveyed with the greatest facility? You will find the distance is less, and the means of communication will be infinitely greater than that which now exists. He pressed this upon them as a reason why this is not a measure that ought to meet with disapprobation, because it interferes with the property of the noble persons who are petitioners against the Bill. He then bestowed a just encomium on the advantages of inland navigation, particularly the Duke of Bridgewater's Canal, to the trade and manufactures of this country, and observed, that if there was one thing more than another that has enabled us to enter into successful competition with foreign nations, it has been the great facilities of our inland communication, which would be rendered still more expeditious by the application of steam on the land carriage of goods. America and Russia, he stated, were beginning to form railroads, and to make use of locomotive engines in the transit of goods, and it behoved this country to resort to the same means of communication; and, lastly, he referred to the advantage that would arise from the proposed railroad, of enabling Ireland to bring her produce into the British market on as good terms as the Dutch, and some other foreign nations."

The whole of the first day was occupied with this speech, and during eleven days immediately succeeding, witnesses were examined, chiefly persons engaged in trade in Liverpool and Manchester, to show that the means of transit by the canal were both inefficient and slow. The statements made, more than bore out all the assertions on this head in the opening speech of the counsel for the railroad proprietors. Two or three interesting extracts may be made. The inconvenience and delay arising from locks on the canal were thus clearly pointed out:—

"The number of flats that can be navigated on any canal is limited by the quantity of water wherever there are locks. There are eleven locks, I believe, at Runcorn. I am speaking of the Duke of Bridgewater's Canal. The time employed for a flat to get through the eleven locks at Runcorn depends materially upon the turn; if there are thirty or forty flats, they cannot get through all at a time. Only one at a time can pass; I suppose, if there are no impediments, she would pass them in an hour and a half. A want of water would add materially to the difficulty of passing these locks. I have known flats detained three tides after a long gale of wind, which was occasioned by the number of vessels which have accumulated in consequence of the bad weather. A vessel can only fill one lock at once;

as soon as she passes, another may enter; there may be eleven flats passing; so that eleven flats may be an hour and a half in passing through. I am speaking supposing there is no other impediments. I do not mean that each flat would require an hour and a half. I say, if the vessel had no impediments in her way, I have no doubt she would pass those locks in an hour and a half; consequently, a second vessel would pass in the same hour and a half, with the addition of the time occupied by the first flat passing the first lock."

Another witness thus described what may be called the "rolling stock" of the canal, which contrasts forcibly with "the plant" of a railroad. A "flat," it is perhaps necessary to say, is a heavy, Dutch-built boat, carrying a low mast, two or three great brown sails, without bulwarks on the deck; and sometimes so deeply laden, that the deck is nearly level with the water:—

"We make flats to carry as much as forty-five tons. A flat is well worth 600 guineas. It lasts, according to the usage, twenty years, when repaired, and some thirty years. I think the Old Quay has had some as long as that. The average cost of keeping a flat in repair for twenty years would be, I should think, taken altogether, £30 or £40. A hundred guineas will do, taking in the rigging. That is quite enough. The wages of a flat are £2 13*s*. a week, besides the driver, that is, for the hands, including the captain, the men, and the boy. The driver receives 14*s*. Two horses, upon an average, are required to draw a flat the whole distance. We change three times, and the Old Quay four. They are put in stages, so that we do not reckon so many to a flat. We send two horses at a time, and they change at every stage. We keep thirty-two horses for our eighteen flats; the price of a horse for a flat is generally about £20; but it is higher now. We must now give £30 for what we formerly gave £20. We reckon all our horses together cost 20*s*. a week average, but probably you might put down 17*s*. for each horse; and the cart-horses come in so harassed that we are obliged to give them beans, and the very best provender. The expense of the repairs of the harness, and so on, and the shoeing, I never made a calculation of. We shoe our own horses, and keep a man to mend the harness; but £5 for a horse per annum is sufficient."

Two curious episodes occurred during the examination of witnesses, in proof of this part of the case. Mr. William Brown, at present Member of Parliament for South Lancashire, had given very strong evidence in favour of the promoters of the Bill. After his examination, the opposing counsel, thinking they had made a great discovery, objected to Mr. Brown's evidence being recorded,

on the ground that he was a shareholder in the Company, and, therefore, an interested person. But Mr. Brown, on being recalled, soon silenced this objection. He said,—

"I was a subscriber to the proposed railroad, but am not now. I have received back the deposit that I have paid. I am no longer a proprietor. I received back the deposit since I came to town. I delivered the shares back to the Company; those shares at that time were at a premium. I took my deposit back. I cannot tell the exact date, but my note to the chairman will show it, perhaps ten days. The release I have from the subscribers is here (producing a paper). I am not a subscriber, directly or indirectly. I do not expect to receive any emolument whatever, from the shares which I formerly possessed; I mean to say, that there is no understanding subsisting, in virtue of which the shares are to be re-transferred to me, in case of this Bill passing. I only expect to receive a general emolument by the advantages the railroad is likely to afford to the public in general. I have renounced the receipt of the premium which these shares now bear. I gave up my shares, because I was told that I could not be a competent witness without doing it."

Sir John Gladstone, the eminent merchant, and father of William Ewart Gladstone, Esq., M.P. for the University of Oxford, was one of the members of the Committee; and strange as it may appear to us now, he was examined as a Liverpool merchant, and gave his evidence on the twelfth day so decidedly in favour of the scheme, that the following question and answer passed between him and one of the opposing counsel:—

"*Counsel.*—You are perfectly satisfied with the general information you have received upon the subject; you are perfectly satisfied it will be expeditious and economical, though the question is to be decided by the Committee upon the evidence?

"*The Witness.*—I am satisfied, but I have changed my opinions before, and I may be induced to change them again."

The witnesses next examined were the engineers, the first being Mr. J. U. Rastrick. He stated that he was a civil engineer at Stourbridge, and had made, during the eighteen years he had been so employed, a large number both of condensing and of high-pressure steam-engines. In his opinion high-pressure engines were not more liable to accidents than others; and they were preferable, because they could be applied in many situations, such as those where there is a scarcity of water, in which condensing engines could not be used. He had made a locomotive engine ten or twelve years

previous, and had made several observations on the working of locomotives, on railroads in connexion with coal-works in the north of England. He then gave a description of the parts and the construction of a locomotive engine, and proceeded to state the results of experiments, which, in conjunction with Mr. Stephenson and others, he had made on locomotives in the north of England. During January of that year, the first engine they tried was one at Killingworth, which they met coming down the line with a train of wagons. It had been at work since five o'clock in the morning, and had not been in any way prepared for experimental purposes. The length of the road on which the engine was working was 2200 yards, or about a mile and a quarter. The ground was undulating, the total rise being from five to six feet. The rails were partly of cast and partly of wrought iron, and in some places had been laid down for horses. The road was in bad order, and so was the engine. Besides, there was a very sharp curve in the road. The wheels of the engine were four feet in diameter, and the entire weight of it, including tender and coals, was 9 tons 14 cwt. The train consisted of twelve Newcastle chaldron wagons, all loaded, and weighing altogether 46 tons 4 cwt. The engine being started, drew this train along the road, that is a mile and a quarter, in twenty-four minutes, but, in returning, owing to the difference in the gradients, it only occupied eighteen minutes; that is to say, the speed going up was at the rate of 3½ miles per hour, and coming down 4¼. The quantity of coals consumed on both journeys was 170½ lbs. Other experiments were made showing the following results:—

Weight.	Rate of speed per hour in miles.	
40 tons 10 cwt.	Up 4·445	Down 4·285
32 tons 16 cwt.	Up 4·205	Down 5·172
67 tons 19 cwt.	Up 3·947	Down 4·838

This third experiment was with another engine, whose wheels were only three feet in diameter, but the four-feet wheels of the other were put on this, and the result was as follows: with the engine alone a speed of ten miles per hour was obtained, and with a load, including the engine, of about sixty tons, an average speed of six miles and two-thirds was gained. In these latter experiments it required a consumption of about 1¾lbs. of coal and half-a-gallon of water to take one ton of goods one mile. He conceived that the engines might be so improved as to require only 1lb. of coals, and be able to carry forty tons at the rate of twelve miles an hour. Such engines could be made perfectly safe.

Mr. Rastrick then gave the results of some other experiments

made on a line about two miles and a third long, at Hetton colliery, near Sunderland. On this line there were at that time three locomotives working, the Dart, the Tally-ho, and the Star: all these engines had wheels three feet in diameter. The first engine taken was the Dart. This road formed an inclined plane, but the engine drew a weight up of about thirty tons at a speed of 5⅔ miles an hour. In going down the incline steam was not used at all, as the train descended by its own gravity, at the rate of about five miles an hour. The steam-engine can be advantageously applied to a railroad, "Because in the first instance you can obtain a greater speed than you could conveniently do by horses; your engine is not tired at the end of the journey; it can keep up its speed during the whole of its journey, provided you supply it with the necessary fuel and water; you are not obliged to stop but only to take fuel and water, so that you may go on all day, or work a whole day or a week, merely stopping at such times as is necessary to take in the coal and the water. It is superior to a water conveyance, because a greater speed is obtained with an equal power, speaking with regard to cheapness: the speed on a canal could not be increased beyond three or four miles an hour, whether it is produced by horses or other power. The advantages of a railroad are that there is never any delay upon it, while a canal is closed ten days during the summer for repairs. On a railroad, the repairs may be done without stopping the trade."

A curious question was then asked of the witness, which, with the answer, we give in full:—

"Q. I have only one question more to ask you. I wish to know if you have made any observations with respect to the effect of engines, with a train of wagons after it, in motion, upon horses; or upon horses in wagons, going along the road? A. Yes; I had a very good opportunity of making an observation, and I called the attention of the rest of the gentlemen that were present with me to it; for the fact was, that we were taking the level of the road at Hetton —the railroad crosses the turnpike-road that goes from Sunderland to Durham. When we had fixed our station-staff upon the centre of the road, to take our levels, at that very instant the wagons came up; and the wagoner who was passing was riding inside. I called out to him to stop his horses. He did not get out of the wagon to stop his horses; but, being a covered wagon, he merely lifted up the cloth and looked out, and stopped the horses. Before we had finished our observations, one of the locomotive engines, with a train of wagons behind it, came up at the speed of about

five miles an hour: the leader-horse in the wagon was within five or six yards of the road where the carriages passed. It was a young horse. He did not seem to be frightened with the train of carriages running past him with that velocity; it made him, certainly, look a little wildly. At the same instant a gentleman, upon a very young horse, rode up till his horse came almost in contact with the wagons. He checked his horse for about a moment; just let the wagons pass; his horse was not at all afraid, any more than he would have been at the passing of a stage-coach; and the wagons passed over the road in about the third part of a minute. To this I called the attention of the other gentlemen, at that moment, in order that they might themselves recollect the circumstance."

Mr. Rastrick was subjected to a severe cross-examination by Mr. Alderson, in which, however, his evidence was not shaken. What the lawyer made of it may be gathered from our extract from his own speech in summing up:—

"I think," he said, "they have given us a theory against the practice. A controversy arose between Mr. Rastrick and me affecting the rate of travelling with those machines; he admitted, that in the case of an engine standing still, and kept from moving by a weight sufficient to prevent it from moving forwards, and operating over a single fixed pulley, though the wheels of the engine should, by an increase of the power of the steam, turn round more rapidly, it would produce no increase of moving force, and the engine would continue to stand still. But he says, and says truly, that when the engine is in motion, if there be a moving force sufficient completely to overcome the resistance behind it, if there be no slipping of the wheels, the engine will then move forward more rapidly in direct proportion to the rapidity with which the wheels turn round. I agree to that, if the fact be so. But it may happen that the machine is not perfectly steady upon its wheels: these may slip back; the weight may perhaps overcome the moving force in question, produced by the friction, the slipping back may increase as the weight to be drawn increases, and the question is, will there not be slipping which has a tendency to counteract the power of the machine to go forward? Mr. Rastrick admits to me, that if on an inclined plane you get to a certain elevation, the machine may turn its wheels round, but will not go forward or backwards; because, in that instance, the resolved part of the force of gravity on that plane is exactly sufficient to counterbalance the friction by which the machine is intended to be propelled, and the one counterbalancing the other, the whole will remain *in equilibrio*. Now, if we have

an engine moving at a certain rate, not indeed upon a level plain, but upon another and less inclined plane than the one on which it will stop, I say, it must, *pro tanto*, slip back. In the first case put, it must slip back altogether. In the inclined plane, when it arrives at such an inclination as to stop the machine altogether, it is palpable that the progressive motion is equal to the slipping back. There is a progressive motion arising from the turning of the wheels, and a slipping back arising from the inclined plane. In this extreme case it slips back altogether. Now, in the other case, I say, the slipping back will be in proportion greater or less according to the weight to be dragged up and the inclination of the plane. If my position be true,—and I am not conscious of any fallacy in it—is there no mode of ascertaining it? I say there is. The number of the strokes of the piston compared with the progressive motion, will exactly show the quantity of slipping back. If the whole space moved over by the engine does not equal the whole of the space, as shown by the multiplication of the circumference of the wheels by the number of strokes of the piston, it is clear the machine must have slipped back. Do not they know this? Why, I did but ask Mr. Stephenson, 'Do you go up an inclined plane?' 'Oh,' says he, 'I know what you are after—there is no slipping back.' Then, I say, why do you not count the strokes of the piston, and give us the means of ascertaining whether you are right or wrong? But what must the Committee think of a witness who says, 'It cannot be so,' and yet will not make a decisive experiment to prove whether he be right or wrong. I will, however, show by the evidence now given by one of our witnesses, — I mean this young gentleman who stands near me—that Mr. Stephenson is mistaken. The Committee will recollect, that these experimentalists did count the strokes in the first experiment, and they say that they did not count the strokes of the second. This gentleman did so; and if I am right, the second experiment will confirm my view of the case; if I am wrong it will not. Let us try:—They say there were 536 strokes of the piston in going up the first time, which will cause a certain progressive motion. Every person knows that the proportion of the diameter to the circumference of a circle is about 3·1416. The wheels were four feet in diameter. If so, 536 stokes of the piston (which would produce 536 turnings of these wheels) would give 6735½ feet. According to that the machine would have gone the distance of 6735½ feet; but, inasmuch as the space was a mile and a quarter, the actual progressive motion was only 6600 feet. It follows that there was a slipping back in ascend-

ing of 135½ feet. It must have slipped back to that extent. It had thirteen wagons behind it. Now observe what in the second experiment it did with only eight wagons behind it. This would produce a less retardation; and this young gentleman has shown that when there were only eight wagons behind it, the same distance was accomplished in 520 strokes of the piston, and consequently there was then only a slipping back of 35½ feet. Now, to what is it that the Committee can attribute the additional slipping except to the greater weight behind the engine? This is the state of facts in ascending: in descending it is different. When the weight is behind, then the whole weight slides forward together. It is palpable, then, that the weight behind neither accelerates nor retards the engine, the consequence is that the engine runs, as it were, alone down the plane, but it has the whole weight attached to it, and acting upon it when it goes up. Does not this again confirm, and is confirmed by what this young gentleman has stated, viz., that in descending, in both experiments, the strokes of the piston are equal? Where the same circumstances occur, they are equal; but where there is a weight dragging behind, there is a slipping proportionate to that weight; and I put this fact against all their theory. There are none so blind as those who will not see, or none so foolish or rash as those who will not make experiments to show that their hypothesis is wrong. They say all this is attributable to a slip arising from a turn in the railroad. But is not the turn there equally whether there are eight wagons or twelve, even admitting that any turn does exist thereabout, respecting which there are contradictory statements? I say also that the turn will equally apply to the ascent as to the descent. But, in point of fact, the engine slips *backwards* in going up and *forwards* in going down. Does not that show the nature of the adhesion of the engine to the railroad, and that Mr. Rastrick is not correct in his view of the case? It is palpable upon the face of this transaction that a great deal of jockeyship has been used to make those experiments. He said that he casually met an engine with four-feet wheels; whereas, when that respectable gentleman, Mr. Wood, was called, he said that it had been prepared, and the railroad had been prepared, and the experiment had been prepared; and now it appears that not only had they prepared what experiments they would make, but also those which they would not make. A more uncandid mode of making experiments I think could not be, especially when they do not examine Mr. Cubitt, the only disinterested person.

"So much then for these experiments, which I cannot help thinking

very fallacious. But I agree these engines have been in use some time, and they have been in use at an average speed of three miles and a half to four miles and a half an hour; that is a fact which no one can dispute, which it would be idle and foolish in me to dispute. Neither do I mean to say, that they might not go more. I do not mean to say, upon a better investigation of the matter, that these machines might not be made to go at the rate of five or six miles per hour, which only now go from three and a half to four miles an hour; but I am satisfied the Committee will not, as they ought not, act upon mere surmise and conjecture. In the case of an experiment, the fire is properly kept up, and to show how material that is, I appeal to Mr. Palmer's experiment, who proved that the strokes of the piston varied from thirty-six to fifty-seven in the course of thirteen minutes. What does that show? It shows this, that it is necessary to keep up the fire very carefully, and that the various accidental causes to which it is exposed may reduce its speed in thirteen minutes to one-half. Therefore, when my learned friends are talking of the experiments being a criterion of the average speed at which these engines can go, I say it is not a fair criterion, and *I say there is no evidence upon which the Committee can safely rely, that, upon an average, more than three and a half or four and a half miles an hour can be done.* Consider the nature of the engine: it consists, in part, of a large iron boiler, and the elastic force of steam is the moving force, and that depends upon the quantity of heat; the water is inclosed in a boiler of iron, a most rapid conductor of heat, and which must move in storms of snow, in storms of rain, and during the times of frost. At all those times it will be extremely difficult to keep up the elastic force of the steam: I do not say it is impossible, but extremely difficult. The common engine is different: there the weight of the atmosphere is brought into play; but then it would be too cumbersome for the purposes to which these engines are appropriated. Now, Sir, I say there will be great difficulty in keeping up the elastic force, and the circumstances brought out in examination confirm it; for it appears that those engines have coverings for the purpose of preventing the heat escaping: they are obliged, in the short distance they go on the collieries, to carry either wooden or woollen coverings; this shows the rapidity of the escape of the heat, and perhaps that does not wholly prevent it. Why, one shovel full of coals put upon the fire at an improper time, would reduce the number of the strokes of the piston from fifty to thirty. These are circumstances which cannot occur at the time of the experiment, but they will operate when you have careless men to deal with. It is

certain you will not have always careful men, as certain as that you will not have a perfect railway, in spite of what Mr. Stephenson has stated. Then, as to the danger. Oh! says the maker of these engines, they are perfectly safe. Why, did you ever know a manufacturer think his engines dangerous, or a gunpowder maker say that his powder mills were not free from danger? But there must be some little degree of danger, or I should not have found this clause put into the Bill itself: 'And whereas it is expedient, for the more complete accommodation of the public, and the greater security of persons passing along the said railway,' (this is what the Company themselves say, who call Mr. Rastrick to prove there is no danger) 'as well as for the better management of the undertaking, that all locomotive, and other moveable engines, employed on the same railway or tram-road, should be constructed on the most improved principles, and in the most substantial manner; and that they should be under the superintendence of the said Company of Proprietors.' So that they are conscious that locomotive engines do require some security; and so great, in their judgment, is this danger, that they take a monopoly of all the engines, to such an extent as to take them all into their own hands! How would they take such a monopoly, unless the engines were attended with danger? It is not, therefore, my opinion alone, but thus out of their own mouths I judge them. But we have been told they are safe. What is the meaning of safety? It depends upon circumstances. A loaded gun is a safe thing in the hands of a gamekeeper, but who would say it was a safe thing to leave in a house with children? Everything may be safe in the hands of careful men. But in the hands of careless, and obstinate, and self-willed people, (as there necessarily must be) then it will not be safe. But the question is, will the accident, if it happens, produce great mischief, for that is really the criterion to judge of safety? But, say my learned friends, we have got a lock-up safety-valve, the only thing that was wanted to give perfect security. Now, what was the danger from the ordinary safety-valve? Why, this; when a man was anxious to get on more rapidly than he ought to do, he loaded the safety-valve, and wilfully exposed himself to danger: this then arises from his own wilful act. Then I ask, if the lock-up valve is not in his power. 'No,' says my learned friend, 'the rivets are in the inside.' Who cleans the machine? Why, this wilful man, by a hole at the end; so that there is a '.ole by which he can get in; and when he is in, what is to prevent him from undoing the rivets, and thereby enable him to load the valve? It is a cumbrous thing, for which a man may get a patent; but when he has

got the patent it will be of no great use. In a stationary engine, it may be different; there the master of the place is about the engine, and he may adopt means of proving that the machine is safe at any precise period of time; but what is true of a machine, which is under the perpetual inspection of a master, is not applicable to an engine under different circumstances. This is a specimen of the real care which engine-makers have for their clients, or rather, I should say, for themselves. Now, I do not say that the circumstance of a man being so wilful as to weigh down the safety-valve, in the way I have mentioned, is of much importance; I should say, let him commit suicide: he may, if he pleases, in this way, as well as go and throw himself into a river. But, I say, this pompous parade of a perfect safety-valve shows the laborious trifling which has been resorted to, by my learned friends, to prop up their case. I say, then, there is nothing proved before you, that any practical advantage can be attained by the railroad, in point of speed, over the canal. It is clear, up to four and a quarter miles, the advantage is equal, and there is no distinct evidence to show that these engines will go more."

Mr. George Stephenson was next examined. After telling who he was, and how he had been employed, he said, that since he commenced business he had constructed fifty-five steam-engines, of which sixteen were locomotives. He knew of a locomotive engine in work at Leeds, which was worked with a cogged wheel fitting into ratches in the rail; but he had thought these unnecessary, and, accordingly, all his engines were constructed without them. He thought locomotive engines a better means of conveyance than canals, because they were cheaper and safer. A locomotive engine may be as safe as a condensing engine, by making the boiler proportionably strong to the pressure it has to bear. It may also be kept in order as easily as a common engine, and the safety-valve may be kept from derangement by the engine-man. His experience taught him that such engines could be wrought with safety, and that the boiler might be made stout enough to resist the atmospheric pressure, and that of the steam. The engines could be made to go with perfect safety, at a speed of from five to six miles an hour. "On such a road as the Liverpool and Manchester, I have recommended eight miles an hour with twenty tons, and four miles an hour with forty tons; and I am quite confident that much more might be done. Those engines, when in motion, are very easily managed, much easier than a horse. They could be stopped in a quarter of a minute, and even less than that, considerably less. Quite as soon as you could stop a stage coach."

Mr. Stephenson was then examined on a point that seems to have been considered of great importance, namely, the effect of locomotives on horses. The following amusing dialogue took place:—

Q. Are they formidable to horses?—A. No more than a mail-coach. Not so much.

Q. I suppose there are some horses which will shy at a mail-coach? —A. I have seen the mare which this gentleman rode shy more at a mail-coach.

Q. Had it been your own horse?—A. It had.

Q. I really thought it had been a canal-horse.—A. It was a canal gentleman that was upon it.

Q. There are some horses that will shy at anything; for that is what it comes to?—A. Yes. I can only say that there was a good deal of the mule in it.

Q. Was it one of those horses that will put its head into a hedge or a ditch if it meets any thing?—A. Yes. Something of that sort.

Q. It would shy at anything?—A. Yes, it would at a wheel-barrow.

Q. Joking apart, do you conceive that a well-broken horse would face one of the engines?—A. It would. I have seen a well-bred horse come close up to one.

In answer to other questions, he said, horses at plough in the fields took no notice of the engines; he had never heard the farmers complain, and the horses that he spoke of were neither blind nor deaf, but in full possession of their senses. He considered it would be quite practicable to make an engine to take thirty tons at the rate of eight miles an hour; and he had no doubt they might go at the rate of twelve miles.

And then, the formidable Mr. Alderson rose and cross-examined the engineer. The cross-examination was long and tedious; confined, at first, chiefly to the question of slipping, referred to in Mr. Alderson's summing up. The chief part of the examination, with regard to speed, was as follows:—

Q. What would be the momentum of a body of forty tons moving at the rate of twelve miles an hour? A. It would be very great.

Q. Have you seen a railroad that would stand that? A. Yes.

Q. Where? A. Any railroad that would bear going four miles an hour; I mean to say, that if it would bear the weight at four miles an hour, it would bear it at twelve.

Q. Taking it at four miles an hour, do you mean to say, that it would not require a stronger railway to carry the same weight twelve miles an hour? A. I will give an answer to that; I dare say every person has been over ice when skating, or seen persons go over, and they know that it would bear them at a greater velocity than it would if they went slower; when it goes quick, the weight in a measure ceases.

Q. Is not that upon the hypothesis that the railroad is perfect? A. It is, and I mean to make it perfect.

Q. I ask you whether if one rail were to be out of its place a quarter or a half an inch, whether that would not produce a complete negative to your proposition,—suppose one of the rails were to slip aside? A. They cannot slip aside, if they are properly constructed.

The Committee then took up the examination, and in answer to their questions, he said, that if, going at the rate of nine miles an hour with a heavy load behind, the engine were upset, the load would not be overturned. The machine may be suddenly stopped by a break upon the wheels, which would disengage the weight behind instantly; so, that going at the rate of nine miles an hour, everything would be safe on a sudden stop. But he has never done so. The wagons and engine could be made to stop at the same instant. It is done by means of a lever connected with all the wagons, and which reaches to the engine. Locomotive engines in England, on railroads, draw goods over them at the rate of six or seven miles an hour; but he could not state an average. But the convenient rate is four or five miles an hour. Locomotive engines not as likely to explode as fixed high-pressure engines, because the boilers are more exposed in buildings, and more liable to corrode. In the other case the tube only is exposed. But fixed engines may be constructed in the same way. He did not know that fixed high-pressure engines had done more mischief than condensing engines. He had known Bolton and Watt's low-pressure engines explode, as frequently as high-pressure engines, which are not more liable to explode than the others, if made proportionably strong. He had often observed the railways stopped by snow. Two or three winters previous the road had been stopped by snow three or four days; but it so seldom occurred that he could not refer to the time it happened. The average speed is four or five miles an hour, if business required it they might go more; six or seven. No engines attended by him had exploded for these last seven years, except in the tubes.. Had

seen an instance where the engine came in contact with the iron, but it went on without any stop.

The next witness examined was Mr. Nicholas Wood, the manager of the Killingworth Colliery, on the railroad of which the experiments detailed by Mr. Rastrick were made. The total length of the railroad was five miles and three quarters, and it had been laid down for about twenty years. It was designed originally to be wrought by horses; but in 1814 locomotive engines were first used. The number of engines that had been employed on the road were four. They were all made by Mr. Stephenson, and were each of the power of eight horses. The number of wagons attached to each engine varied from nine to twelve,—each wagon taking 53 cwt. of coals. A good practical load for one of these engines is ten loaded wagons, which, with the weight of the engine and tender, make altogether a weight of forty-nine tons. An engine with four-feet wheels could travel with this load at the rate of six miles an hour, "or a little more occasionally;" and with three-feet wheels, between four and five miles an hour. A rate of three miles an hour will, however, be sufficient for the purposes of the coal work, the only use made of the railroad being to convey coals from the mine to the sea-shore. The greatest inclination in the road was 1 in 330. The only accident that happened to the engines was the giving way of the fire tube, by which one man was scalded. He then detailed, in the same manner as Mr. Rastrick, the results of the experiments made at the coal-work; and the following were the questions and answers with regard to the speed at which he considered locomotive engines might go:—

Q. Have you any doubt that a locomotive engine could be made to take the weight of forty tons, at the rate of six miles an hour, with perfect safety?—A. An engine may go six miles an hour with forty tons,—that is, including the weight of the carriages.

Q. Have you any doubt that the power of the engine might be so increased as to take that weight at any speed between six and twelve miles an hour?—A. I think the power of the engine may be increased to take that weight.

Q. To what extent do you conceive the power of the engine could be increased to take that weight of goods?—A. I can scarcely state that to you: the power of the engine may be increased very greatly.

Q. As much as double?—A. I think it might.

Q. If you had such an engine, in your opinion could it be made

to go with perfect safety twelve miles an hour, with relation to the bursting of the boiler?—A. Yes, I think it might.

Q. At the rate you go at Killingworth, are the engines easily managed,—easily stopped?—A. Very easily.

Q. Is their pace easily slackened?—A. Yes.

Q. Easily started again?—A. Yes.

Q. In short, they are easily manageable?—A. They are.

Q. Do you think they could be made perfectly manageable to go at the rate of eight miles an hour?—A. Yes, I conceive they might, at eight miles an hour.

The cross-examination of Mr. Wood was very short, and no new fact of importance was elicited. This concluded the evidence with respect to the inefficiency of the existing means of traffic between the two towns, and with respect to the capability of the locomotive engine to carry goods faster than they could be conveyed on the canals. On the fifteenth day, the Committee proceeded to consider the details of the proposed line between Liverpool and Manchester.

Mr. George Stephenson was the first witness called. He stated that he had been employed to survey the proposed railroad between Liverpool and Manchester, and had made the estimates of the cost, which he handed to the Committee. These estimates were as follows:—

Excavations, &c.	£87,599
Bridges and masonry	11,920
Stone blocks	15,557
Chains or pedestals to receive the rails in the stone blocks	16,028
Rails for thirty-four miles	64,710
Laying the rails	14,960
Fences	5,129
Four hundred gates	600
Wagons for use in making the line	4000
Twenty locomotive engines, at £600 each	12,000
Boilers, cranes, and machinery	35,000
Warehouses, offices, &c.	25,000
Obtaining the Act of Parliament	10,000
Contingencies	26,596

exclusive of the value of the land, of which 303 statute acres would be required.

Mr. Stephenson was then subjected to a severe cross-examination by Mr. Alderson. The chief object of the learned counsel seemed to be to show that many circumstances had not been taken into

account by Mr. Stephenson; that all his calculations were extremely vague and uncertain, and in some cases founded on erroneous data; and he laboured hard to fix the engineer down to absolute precision in his various statements. On the other hand Mr. Stephenson seemed determined not to allow himself to be tied up to precise details; he seemed to feel all the time that the undertaking was new, great, and unexampled, and that it was impossible to avoid errors at the outset; he seemed to be perfectly confident that all the difficulties could be overcome, though when hard pressed, he could not give conclusive scientific reasons for his confidence; the precision of the lawyer, therefore, contrasts very broadly with the vagueness of the engineer, and the impression on the minds of the Committee could not be other than unfavourable to the scheme. A few specimens of the tilting between the counsel and the witness may be given:—

Q. I think that your plan, as laid before the Committee of the House of Commons, was to cross the Irwell (begin at the Manchester end, if you please) by a bridge, is it not? A. It is.

Q. What is the width of the Irwell there? A. I cannot say exactly at present.

COMMITTEE.

Q. Have you any memorandum? A. I have not of the bridge.

MR. ALDERSON.

Q. Is it not about 100 feet or upwards? A. I cannot speak to that.

Q. How many arches is your bridge to have? A. It is not determined upon.

Q. How could you make an estimate for it, then? A. I have given a sufficient sum for it.

Q. What sum have you given? A. £5000.

Q. If it is made of one arch, will it not be from 100 to 120 feet span? A. It is not necessary, so long as we leave a sufficient space for boats to pass.

Q. What is the height of the bridge over the river Irwell—the intended one? A. From twenty to fifteen feet.

Q. Which is it to be? A. I would rather say fifteen.

Q. Then is your plan calculated for a bridge, taking the suffete of the arch, and the ordinary surface of the road at ordinary tides,

what is the height of the one above the other? A. Fifteen feet above the level of the water at the time the plan was taken.

Q. Will you not say it is ten feet according to the plan? A. Perhaps it might be so.

Q. Where is the plan? A. I do not know: it might not measure the height that I took myself.

Q. I will take it for granted to be ten feet? A. I am sure it is more than ten feet.

Q. Can you tell me what the height of the bridge immediately above that bridge is above the level of the water; is it not twenty-five feet? A. I think it is somewhere near to it.

Q. Eccles bridge I am speaking of? A. Yes, that is the bridge.

Q. About three-quarters of a mile higher? A. No, not so much; about a quarter of a mile.

Q. Does not the river Medlock fall in between that bridge and the bridge you project? A It does.

Q. And you do not mean to deny that Eccles bridge is twenty feet above the ordinary level of the water? A. I cannot speak to that.

Q. Though that bridge does not carry off the water of the Medlock as well as the Irwell? A. It does.

Q. Has it anything to do with the water of the Medlock? A. I dare say not.

Q. Though the Eccles bridge has only the water of the Irwell, and the projected bridge will have the joint waters of the Medlock and the Irwell, and though the other bridge is twenty-five feet in height, your projected bridge is only ten feet, do you not know that Eccles bridge is itself insufficient sometimes for carrying off the water? A. I do not know that.

Q. Have you made no inquiries? A. I have not.

Q. Do you not think it necessary in making a bridge to make inquiries as to the quantity of water to be carried away? A. I think, if made similar to the other bridge, it is quite sufficient; and I calculated that the water never would reach up to the top of the arches.

Q. Have you made any inquiries as to the insufficiency of the Eccles bridge, that it is insufficient to carry off the waters of the floods? A. I think I did not.

Q. Would your bridge produce an actual stoppage, if that were the case? A. I should think it would to a certain extent; but the height of the bridge has nothing to do with the passage of the water.

Q. Then you say that the height of the bridge has nothing to do with the passage of the water? A. Not unless it reaches up to the top of the arch.

Q. That is the very question? A. I should think no man would make inquiry respecting a bridge made so lately.

Q. Then your practice is to make bridges without such inquiries? A. If there had been any complaints, I should have known of it—when I was looking at the line I must have heard of it.

Q. On the last Christmas-day was not Eccles bridge full? A. I do not know.

Q. I ask you again whether you have made inquiries, or whether you have neglected to make inquiries, as thinking it immaterial? A. I did not think it was a matter of importance to do so.

Q. And you do not know whether your bridge will cause a stoppage in the river or not? A. I should take care to make it so that it would not.

* * * * *

Q. What is the width of the bridge over the river Irwell—not the span of it, but the width of it? A. I have not made out the width, but perhaps fourteen feet.

Q. So you make a bridge, perhaps fourteen feet wide, perhaps twenty feet high, perhaps with three arches, and perhaps with one, and then you boldly say that £5000 is a proper estimate for it? A. I think so.

Q. If it is to be composed of one arch will £5000 do it? A. I think it will.

Q. An arch of a hundred feet span and upwards is as large as one of the arches of Waterloo Bridge. A. I can refer to a bridge as large as that, or larger, at Berwick-upon-Tweed, which did not cost more in proportion.

Q. Where do you mean to begin your railroad? A. Where it is shown upon the plan.

Q. Where is that? All your plans do not agree; to which therefore do you allude; from what point do you mean to start? A. Adjoining Water-street.

Q. Is that in Great John-street? A. You have it upon the plans; I cannot speak to it from memory.

Q. I want to know where the Old Quay Warehouses are—how near to the place where your railway commences? A. I did not measure them; I do not recollect.

Q. Then you did not consider it necessary to measure the dis-

tance? A. So long as there was sufficient way for the railway, I did not think it necessary.

Q. Did you not know that by this Bill it is intended to take some land for warehouses? A. I believe it is.

Q. Does not the limited distance from the termination of your railroad include the warehouses, or part of them, of the Old Quay Company; answer the question distinctly? A. I can only answer that they are not intended to be taken; they may be within that distance.

Q. But the power will exist, therefore the intention is of no use; will not the power exist? What quantity of the warehouses of the Old Quay are within that distance? A. I cannot speak to it.

Q. What is the distance at the nearest point of the Old Quay Warehouses to the point where the Railroad is to commence? A. I cannot tell; it is a matter of no importance.

Q. Answer my question, if you please; you can easily measure it by the compasses. A. I can only refer to it in this way—it is not intended to be taken.

Q. I wish to know as a matter of curiosity. A. It may be within that distance.

The learned counsel seemed to entertain the idea that, in a snow-storm, a tunnel would be drifted up, and he therefore questioned Mr. Stephenson as follows on the subject:—

Q. What sort of effect would snow have upon it there? A. Part of it would get in, but it would depend upon the wind in a great measure.

Q. But would it not fall into this great tube? A. If the wind blew longitudinally, it would get the same quantity of snow in that part as would fall on the adjoining ground; but if it blew at right angles, and a gale of wind, it might then drift in more than the adjoining ground.

Q. Did you ever go up Dunstable-hill? A. Yes; I did.

Q. In the year 1814, the time of the great snow? A. Yes.

Q. Supposing that to be the case? A. I could not calculate more than once in twenty years that such an effect would be produced.

Q. Do you not know that the effect of the snow lying upon th ground, and the wind blowing transversely, would fill it? A. No; it must be a very long storm to fill it.

Q. Would it not have a tendency to fill it? A. That depends upon the state of the wind.

Q. Suppose the wind to be transverse, and the snow lying upon the ground, what will there be to take the snow out when it has got once in; it will then be out of the wind? A. It will fall there.

Q. And there it will accumulate? A. Yes.

Q. By what means is it to be taken out when it has fallen in? A. You could not throw it out at the top very well; but I will throw it out at the two ends.

Q. Then is it not important in that view of it, to ascertain what the length of the tunnel is, along which you are carrying it, or in those deep cuttings? A. I think not; I can only state there are excavations of the same height in the North of England, and they have not been blocked up more than once in twenty years, and which lie in a much higher country than Liverpool, and when the snow lies a much longer time than there.

It was not till near the close of the seventeenth day,—that is, after he had been more than three days under examination,—that the questioning of Mr. Stephenson was concluded. Some idea of the results of his cross-examination will be found from the extracts, which we shall presently give, from Mr. Alderson's speech to the Committee. At the close of the seventeenth day, various witnesses were examined as to the value of the land which would be required; and the result of their evidence was, that the amount necessary for that purpose was £68,840.

On the eighteenth day, Mr. Cubitt, the civil engineer, was examined, with the view of correcting some of the levels as given by Mr. Stephenson; and Mr. N. Wood stated, that the total expense of the four engines on the railroad with which he was connected, was £756 for two hundred and twenty days; and that during that time the work done was equal to the conveyance of 356,180 tons of goods for one mile, which was at the rate of a little less than a halfpenny per ton per mile.

The nineteenth day was occupied with the summing up, by Mr. Sergeant Spankie, of the case on behalf of the promoters of the Bill. His speech was to a great extent a repetition of that made by Mr. Adam at the outset.

On the twentieth day Mr. Harrison opened the case on behalf of some of the landowners on the proposed line. His speech was an elaborate and minute analysis of the evidence, in which he laboured to show that the delays in the transit of goods from Liverpool to Manchester were exceptional: that the Railway Company wanted a monopoly more stringent than that possessed by the canals; that

the experiments with locomotive engines had not been fairly made; and that the scheme of the railroad was crude, imperfect, and unsatisfactory. Of Mr. Stephenson he said:—"I declare solemnly, after I read his evidence through, I could not understand it. He speaks of embankment in one place, and of a level in another, and a cutting in a third. I will prove that it is impossible to lay the railroad across here, unless he raises it nineteen feet above the level which he has contemplated,—unless he carries it up to the top of those intersecting roads; and if he does not, that in every flood that comes into the Irwell, this railroad for one mile will be very often six feet under water. He must raise it to the height I have stated. Therefore, up to this moment in what situation do I stand? I am not enabled to say what this engineer means to do, and I cannot point out the injury that may be done, except that our engineers say there must be a great embankment, which must cover a large quantity of land, and which will interrupt the communications between the different parts of the property, and cut off the road from Liverpool to Manchester. I am met here by the intervention of the section, which gives no information to any person—it cannot inform any body, and I am only to be let into such parts of the case as the engineer will explain, which are very few. Unless, therefore, all the principles which British legislators act upon are lost sight of, this Committee, I am convinced, will see that they cannot act upon the evidence of this man; for he has not, up to this moment, made up his mind how he shall carry into execution a great part of this project."

With regard to the powers of the locomotive engine, he expressed himself in the following terms:—

"When we set out with the original prospectus—I am sorry I have not got the paper with me—we were to gallop, I know not at what rate; I believe it was at the rate of twelve miles an hour. My learned friend Mr. Adam contemplated, possibly in alluding to Ireland, that some of the Irish Members would arrive in the wagons to a division. My learned friend says, that they would go at the rate of twelve miles an hour, with the aid of the devil in the form of a locomotive, sitting as postilion upon the fore-horse, and an Honourable Member, whom I do not now see here, sitting behind him to stir up the fire, and to keep it up at a full speed. But the speed at which those locomotive engines are to go has slackened; Mr. Adam does not go faster now than five miles per hour. The learned Sergeant says, he should like to have seven, but he would be content to go six. I will show he cannot go six; and probably, for any practical purposes, I may be able to show, that I can keep up

with him by the canal. Now the real evidence to which alone you can pay attention shows, that practically, and for useful purposes, upon the average, and to keep up the rate of speed continually, they may go at something more than four miles an hour. In one of the collieries, there is a small engine with wheels four feet in diameter, which, with moderate weights, has gone six; but I will not admit, because, in an experiment or two, they may have been driven at the rate of seven or eight miles an hour—because a small engine has been driven at the rate of six, that that is the average rate at which they can carry goods upon a railroad for the purposes of commerce, for that is the point to which the Committee ought to direct their attention, and to which the evidence is to be applied. It is quite idle to suppose, that an experiment made to ascertain the speed, when the power is worked up to the greatest extent, can afford a fair criterion of that which an engine will do in all states of the weather. In the first place, locomotive engines are liable to be operated upon by the weather. You are told that they are affected by rain, and an attempt has been made to cover them; but the wind will affect them, and any gale of wind which would affect the traffic on the Mersey, would render it impossible to set off a locomotive engine, either by poking of the fire, or keeping up the pressure of the steam till the boiler is ready to burst. I say so, for a scientific person happened to see a locomotive engine coming down an inclined plane, with a tolerable weight behind it, and he found that the strokes were reduced from fifty to twelve, as soon as the wind acted upon it; so that every gale that would produce an interruption to the intercourse by the canals, would prevent the progress of a locomotive engine, so that they have no advantage in that respect."

On the twenty-first and twenty-second days, witnesses were examined as to the effect the making the railroad would produce on the property of the landowners. One of these witnesses had never seen a locomotive engine. Engineers were then called to prove that Mr. Stephenson was all wrong. One of these, Mr. Giles, said, speaking of Chat Moss:—

"In my judgment, a railroad of this description certainly cannot be safely made over Chat Moss without going to the bottom of the Moss. It will be necessary, therefore, in making a railroad which is to stand, to take out, along the whole line of road, the whole of the moss to the bottom, and to cut down to thirty-three or thirty-four feet, and afterwards to fill it up to such a height as the railroad is to be carried over the soil, with other soil mixed with a portion of the moss; and, therefore, if Mr. Stephenson be right in placing the

level of the railroad fifteen feet below the moss, they would not only have to cut out thirty-four, but to build up the other fifteen feet; and, unless that were done, I do not think that a railroad would stand. My estimate for the whole cutting and embanking over Chat Moss is £270,000 nearly, at those quantities and those prices which are decidedly correct. No engineer in his senses would go through Chat Moss, if he wanted to make a railroad from Liverpool to Manchester."

This witness estimated the cost of the line proposed by Mr. Stephenson at a million and a half. He was the projector of a new canal between Liverpool and Manchester, of which he said:—

"The description of boat which the canal would accommodate, would be a small, active, running boat,—a pretty little running fly-boat, that would run about four or five miles an hour; and it will perform the trip in a much less time, as I can make my canal thirty-five or thirty-six miles from Liverpool to Manchester without obstruction of tide-way. The small boats would be able to travel their distance in nine or twelve hours decidedly; I should not have projected it unless I thought it was a very eligible project. From the extent of the trade of Liverpool, I think most conscientiously that it would answer. I suppose we should want a million of money; but I will not finally estimate it until I have carefully tried the foundation of the river Mersey: but supposing the foundation could be overcome by coffer-dams, I think a million of money would complete the whole."

Another of these witnesses, Mr. Palmer, went into an elaborate statement, founded on many experiments, to show the comparative advantages of railroads and canals. The result arrived at was, that at a speed of four miles and a quarter, or under, the canal had the advantage as regarded economy, but, above that, the advantage was on the side of the railroad. Mr. Leather, who made the Croydon railroad, gave evidence also against the Bill.

On the twenty-sixth day, Mr. Alderson made a long and an able speech in summing up. Of Mr. Stephenson, he said:—

"I say he never had a plan; I believe he never had one; I do not believe he is capable of making one. His is a mind perpetually fluctuating between opposite difficulties. He neither knows whether he is to make bridges over roads or rivers, or of one size or another; or to make embankments, or cuttings, or inclined planes; or in what way the thing is to be carried into effect.

"In the first place, he answered me very shortly the first day. 'I shall cut my moss at forty-five degrees; it will stand at that

very well.' Be it so—I am content with the answer. 'Of course (I said) you will drain your road on each side?' 'I shall make ditches.' 'How wide are they to be?' 'Six feet.' 'How deep?' 'Oh! they are to be five feet deep, or four feet deep.' Now, I am sure the Commitee are well aware, that a ditch, if ever it is to come to a point at the bottom, and is to be five feet deep, cut an angle of forty-five degrees on each side, must be ten feet wide at the top. What do you think of the ignorance of this gentleman, who chooses to have an impossible ditch, which he chooses to cut by the side of an impossible railway? Did you ever hear such ignorance as this? Whatever credit you might have been disposed to give to Mr. Stephenson before, it is plainly shown now how utterly and totally devoid he is of common science; for every one who knows that two and two make four would have known that that was an impossible ditch. But he does not stop there. When we come to inquire how Knowsley Moss is to be got over, first, he stated he was to have a channel for the brooks. I suggested to him that there were two brooks which run across the deep cutting of eighty feet, and I wanted to know how he was to get them from one side to the other. He never had thought of them. He said, in the first instance, he would make a channel by the side of the railway. How was that channel to be made? 'I do not know.' How long will it be? would it not be a mile? (which of course would increase the expense.) 'No,' says he, 'I think not a mile.' But suspecting he might be wrong there, 'Then (says he) I will make a tunnel.' I cannot bind him, you see, to any one point. This is the gentleman who is called to prove the estimate and the plan. He cannot prove it. He makes schemes without seeing the difficulties; and when the difficulties are pointed out, then he starts other schemes, which are exposed to other objections. Having said he was to make a tunnel, he is asked how long that tunnel is to be; and he cannot tell whether it is 1000 yards or 100. If he had not known whether it should be 100 or 150 yards, I should not have said anything about it; but how great is his variance, and this through a moss where there is to be a cutting of eighty feet deep. He admits it is material, in order to make a tunnel, to know the strata. Now, let us see what happens next. He says he has made no borings to ascertain the strata; and, therefore, by his own rule, he cannot make an estimate. His own evidence is that he cannot make one. Then the Committee are to say, I suppose, 'Oh! it is not material there should be an estimate; we will make one for ourselves; and though this gentleman, on whom we are to rely, cannot make any estimate, we do

not care. We will pass the Bill,—estimate or no estimate, plan or no plan, right or wrong, the Bill shall pass.' My learned friends will not avow this, but the facts of the case avow it. Having got rid of that, Mr. Stephenson next says, 'I will not make it a thousand yards long; I will make it part tunnel, and part open.' That is the third scheme. Then he says, 'I will not cut or make any tunnel, but we will make inclined planes.' So that we have not fewer than four or five different schemes to cross one moss. Here are five schemes, from which he is successively driven. What, then, are you going to vote for? Mr. Stephenson has produced five schemes, all resulting in one estimate; for whether they are cuts, or channels, or tunnels, or planes, there is the same sum of £26,000 on which he retreats. If he has to cut several million more yards, he has still £26,000 to retreat upon. Why, that will be all expended long before he gets to Chat Moss; but, even supposing he struggles through with this £26,000 about his neck, what is to become of Knowsley Moss, whether it is to have cutting or tunnel, or a part cutting and part tunnel, or inclined planes, no person knows to this very day, including Mr. Stephenson himself. Again, the first day he chose to have planes at Irwell Bridge. 'I will not,' says he, 'have embankments, however high the bridge may be.' 'How, then, will you get over it?' 'I will make two inclined planes, and the wagons shall be wound up by a sort of crank.' I asked him this question, 'Will you stick to that plan?' In a rash hour he said, 'I will.' He was contented to stick to that plan. Twenty-four hours had not elapsed before he went back from it; for when I was going to ask him the question the next day with another object, an honourable member interposed, and said, 'You asked him that question before;' and almost before the words were out of his mouth, it popped out, that he had discovered that embankments might be made, for that he had a superabundance of cutting, and that it would be nothing to have an additional bank. A superabundance of cuttings? I think, upon all the evidence, it is the other way. Then what becomes of Mr. Stephenson's new scheme? The result will be, no doubt, they must have resort to side cuttings, which I believe they have no power to make; for when you give a power to diverge 100 yards on each side of the line, it does not give a power to spoil the whole of the land to that extent, but only to carry the railroad within those limits. If so, they will have to make bargains with each proprietor, and be assured they will not do it at the price that Mr. M'Intosh has put upon the land. If I were to go through Mr. Stephenson's estimate, and the whole of his

evidence from beginning to end, this would be the result. There is a shuffling manner of going into the whole of his estimates. There is no direct evidence given—nothing to which he will bind himself—nothing to which he will stick—excepting that from which he runs in twenty-four hours; and yet it is upon this evidence that you are called upon to pass this Bill."

The learned counsel then entered into a very elaborate argument, to show that a solid railway only was practicable through Chat Moss, and that many of Mr. Stephenson's calculations were entirely wrong. He concluded by saying—"I think you must come to the conclusion that the advantages of the railroad are extremely doubtful and problematical; and if we are so circumstanced, I say that you will, and ought to, entitle me to your consideration. If you have an injury certain, and a right certain—and a right dear to every individual I have the honour to address, and not rashly to be put an end to; and if, on the other hand, you have the mere convenience of carrying cotton at the rate of twelve miles an hour, which now goes, as they say, at the rate of three—then, I do protest against the despotism of the Exchange at Liverpool striding across the land of this country. I do protest against a measure like this, supported as it is by such evidence, and founded upon such calculations."

Mr. Parke then opened the case, against the Bill, of Charles Orrell, Esq. and Sir William Gerrard. The summary of his address, which he gives, shows clearly the nature of the early opposition of landowners to railroads.

"Mr. Orrell, a gentleman of very respectable family, and of considerable property, complains of the intended railway as injurious both to his estate and residence. Sir William Gerrard, the heir of a very ancient family in Lancashire, complains of the railway, not as affecting his residence, but as affecting his estate, upon which there are valuable collieries. When the grievances of which his clients complain are enumerated, in addition to those which have been pointed out in the other landowners' cases, the Committee cannot pass the Bill. It is a principle invariably adhered to by Parliament, that private property is not to be invaded unless there be urgent public necessity. Mr. Orrell is lord of the manor of Parr, and he and his ancestors have resided in their mansion upwards of a century. Considerable sums have been spent in improving the property, with a view to Mr. Orrell's continued residence there, if the railway is not constructed. The proposed railroad will pass within 250 yards of the mansion, and subject it to the nuisance arising from the constant passage of noisy and smoky engines. By a clause in the Bill, it may

be brought to within 150 yards of the front of the house. In the most favourable view of the case, therefore, the nuisance will be within 250 yards of Mr. Orrell's house, and it may be brought to 140 yards, or even to the very mansion itself. Can anything compensate a gentleman for such an injury to his residence and estate, which have long been in the possession of the family? Mr. Stephenson's plan and section are so inaccurate, that the precise extent of the injury to this property cannot be ascertained; neither the height of the embankments, nor the depth of the cuttings, can be known. In some parts of Mr. Orrell's estate there will be embankments of the height of eighteen feet above the surface of the ground; and across the valley through which the Sankey runs, there will be an embankment fifty feet high, which will entirely destroy Mr. Orrell's view of the valley beyond the line of the proposed railroad. The petitioner's case is calculated to make the deepest impression on the Committee, and he doubted not that they would protect the petitioner's property from unnecessary and uncalled for violation. If the Bill passes, it must have the effect of driving Mr. Orrell from his ancient family residence. In the case of the Tees and Weardale Railway, the Bill was lost, because the line of railway passed at the distance of half a mile from a gentleman's residence, whilst in the present case it is proposed to bring the railroad within 250 yards of the petitioner's residence. There are also other injuries of which the petitioners complain. Mr. Orrell is the proprietor of valuable coal mines, which the provisions of the Bill will entirely prevent him from working. The Railroad Company are only to pay for the surface of the ground, and the proprietor of the colliery is to receive no compensation for the value of the coal which he will be obliged to leave under the railroad, in order to avoid the risk of injury to it. Mr. Orrell's coals, and Sir William Gerrard's, lie near the surface; and it will be necessary to leave a barrier to the extent of forty yards on each side of the railroad, beside that which is immediately under the railroad. But that is not all: it is proposed that Mr. Orrell and Sir William Gerrard shall not be permitted to construct any additional drifts, or cuts, or other works under the railroad; in consequence of which the communication between the different parts of their respective collieries will be entirely interrupted; the consequence will be great expense and great inconvenience and loss. Another objection to the proposed railroad is, that it will cross Mr. Orrell's private railway and interrupt the conveyance of his coals to the Sankey Canal. Although the loss of coal, and the injury to the private railway is compensable, yet the injury to Mr. Orrell's residence

is beyond all compensation. It is obvious from the evidence in support of the Bill, that the projectors of the railroad do not propose to pay any compensation beyond the value of the surface of the land actually occupied by them, and that their estimates include no calculation for the value of the solid coal that will be lost, or the injury to Mr. Orrell's railway, which in fairness and justice they ought to pay; and also to pay Sir William Gerrard for depriving him of the communication between his colliery and the navigation."

In cross-examination of the witnesses called in support of this case, it was shown that Mr. Orrell could, in his own house, hear the noise and see the smoke of the engines employed at his coal works; that the turnpike road was fifty yards from his house, and that a coach changes horses very near it; and that in the immediate neighbourhood there were a public-house, a grocer's shop, and some brick-kilns.

On the twenty-ninth day, the case of the Trustees of the Duke of Bridgewater was opened by Mr. Mac Donnell, and a great number of witnesses were subsequently called to support it. The cases of the proprietors of the Irwell and Mersey Navigation, and of the Leeds and Liverpool canal, concluded the opposition to the Bill. The leading features of the opposition of the three parties who collectively represented the canal interest, will be best gathered from the speech of Mr. Harrison, who summed up the case in their favour.

"I now come, sir, to comment upon the locomotive engines. I entreat the Committee to recollect how this project has arisen, and I will ask every honourable Member, whether any human being would have thought of setting up a railway between Liverpool and Manchester, if that railway were to be conducted by horse power? I say it never entered into the imagination of any one. But, amidst all this mania that has possessed us, (for we have been running mad after projects and schemes of all sorts, kinds, and descriptions,) locomotive engines have started up, patronized and supported by some, for the purposes of showing their ingenuity in writing essays and pamphlets, and by others for the purpose of being employed as engineers, or otherwise. To make the thing popular, a certain number of ingenious gentlemen are set to write pamphlets; how many, or of what size, I do not know; and, I believe, at last, we have got down to a review. But we have not only books, and pamphlets, and essays without number—we have beautiful pictorial exhibitions of locomotive engines at full work, one of which is now lying before me. One ingenious gentleman has got a beautiful impression of a locomotive engine, with carriages, and guards standing behind them, giving a description of seven or eight stage coaches, with trumpeters and

guards, and all the paraphernalia, galloping on at a rate of several miles an hour. Whether such an experiment ever will be made, I do not know; but I think, when I come to comment upon that part of the case, many persons, who have thought them very beautiful things, will be sick of the experiment. The project of this railway was entirely founded upon the locomotive engines; it was set on foot with a view to the expedition which would be derived from the use of them. All the pamphlets published about it, give us twelve miles an hour as the rate at which they were to go: you were to gallop from Liverpool to Manchester at the rate at which the mail-coaches have tried to go, but never accomplished. This expedition was to produce such consequences, with reference to the trade of the two places, as almost to unite them in one, so quick would be the change of the bags of cotton and other articles. All this, in the natural order of things, produced subscribers; it gave rise to all sorts of calumnious and untrue assertions, in pamphlets and publications without end, against the existing establishments. I have a right to state (for no attempt has been made to prove them) that the facts alleged are utterly false; that the personalities, which are of the worst description, have no foundation but in the misrepresentations of self-interested parties. Although the Committee would not have admitted any of the personalities to have been proved, the promoters of the Bill might have proved the facts; but they have not done so: on the contrary, they have been directly negatived by every atom of evidence which has been brought forward. I ask, therefore, whether this course of proceeding has been a decent and proper one, considering the subject to which it is applied? Are we placed in the situation we ought to be with respect to the late noble Duke, to whom the country owes more, in relation to her trade and commerce, than perhaps to any one man that ever lived? Is not one generation to pass away, is not the successor of the noble projector to be laid in his grave, before his vast undertaking, which has produced such amazing effects in this country, is attacked by pamphlets containing the grossest falsehoods? thus making the prosperity of Liverpool and Manchester—which is founded more upon the exertions of that noble Duke than upon anything else, and is produced by his sacrifices, and the expenditure and risk of an immense fortune,—the foundation of the ruin of this great property. I say, a greater and more scandalous attack upon private property, from which the public are deriving such immense advantages, never was made—an attack resting upon the only basis it could—falsehood and misrepresentation, and grounded, with regard to proof, upon insidious allegations and the plainest fallacies from beginning to end.

"And now, sir, having made these observations, which arose out of something that occurred to my learned friend at the moment, I will return to the locomotive engine—upon its expedition, and the velocity by which the goods could be carried backwards and forwards, contrasted with all the inconveniences, delays, and losses, arising from the river Mersey and a canal navigation; none of which, however, were proved. Now, sir, how do we stand upon this part of the case? All those promises of expedition of twelve miles an hour (for they do not now pretend to go at so great a rate, though all the pamphlets, and publications, and paragraphs, and reviews talked of this extraordinary expedition)—literally, before the counsel against the Bill had addressed the Committee,—come down to six; and yesterday and to-day we find in the best weather, and under the most favourable circumstances, the expedition is diminished to four or five, and whenever you come to rain or mizzling weather, or damp weather, it is reduced to two, two and a half, and three miles an hour. Is Lancashire a county free from rain? Have you no mizzling weather, no snow there? I should rather suspect—and I am sure I do not mean to calumniate the county of Lancaster—I have travelled through it with great delight—it is a county which has as much rain as any other county on that side of England. Unless then they can rarefy the atmosphere as quickly as the locomotive engines go along, the locomotive engine will have so many inconveniences to contend with, that it will come down to the speed of a common horse power. Now, I ask, would any person step forward to support this measure, if the goods were to be drawn by horses? But not content with goods, they are to take passengers. Now set them off with horses before them, set the proprietors of the railway travelling on their own road, from Liverpool to Manchester, in wagons, at the rate of four miles and a half per hour; it is impossible to state it without presenting something ludicrous to the mind. The Committee will recollect that we had two or three witnesses to speak to the locomotive engines: we had Mr. Rastrick, a man very scientific, very experimental, and well-grounded in all the subjects he spoke to; but he told you that he had never seen a locomotive engine in practice, and I showed that in that very experiment, he ought to have gone further than he did, in order to have ascertained the effect which rain, or causes of a like nature, might have produced. For instance, he might have watered the railroad to see what effect moisture would have had. If Mr. Rastrick had tried the experiment as a man of science, I have not the least doubt but that he must have arrived at a conclusion that locomotive engines are utterly useless for the purpose my learned

friends wish you to believe they are adapted. But Mr. Rastrick knew that if this Bill succeeded he would make engines for a line of railroad of not less than forty-four miles; and by the time the railroads were set a-going, the poor gulled subscribers would have found that they had lost all their money, instead, as they hoped, of putting a good deal into their pockets, and that, instead of locomotive engines, they must have recourse to horses or asses, not meaning to say which. Now Mr. Rastrick never attended to more than one experiment of any consequence; and when he found upon that experiment there was a considerable difference in the strokes of the piston, was he not bound to examine from what cause it arose, and to see what effect was produced, by a careful examination of all circumstances which could produce any effect upon the engine? If a man meant to arrive at a true conclusion, every circumstance affecting the power of the engine should have been made the subject of careful investigation. What the effect is, you have heard from himself; after he had tried the experiment, and saw the result, he never tried it again: he felt he had got into a difficulty; he satisfies himself therefore with putting half a dozen people in the wagon, and then setting the engine off, he finds that it goes at a certain rate; and that it is an experiment which is to lead you to a conclusion that an average speed of five or six miles an hour is to be obtained by these engines, so as to make them available as a means of conveyance. I said before, and I repeat it again, that any practical result which will enable you to arrive at a conclusion is worth all the reasoning, and all the experiments, or opinions of any man, however scientific he may be. Scientific calculations are necessarily mixed up with so many uncertainties, as to render it impossible for any man to say that you can with certainty arrive at a conclusion; but you cannot be deceived when you find them used for several years, and that those engines never exceed four miles and a half an hour; certainly, there was an engine with a small weight that went at a greater rate, but that was not the ordinary rate, and that was the one on which they made the experiment.

"Then, sir, what is the situation in which we stand? I show that locomotive engines cannot move at more than four and a quarter miles per hour, at which you are reduced to horse power, and below that the canal has the advantage; therefore, the instant they lose the power of going above four and a quarter miles an hour, which I have taken from them, that instant the advantage is in favour of the canal. Instead of their having an advantage in bringing forward the railroad, the power stands with us; we have the advantage in power and in every thing else. So that I show the scheme is bottomed

in deception and fallacy, which they may have practised upon themselves; but having got into it, and spent a great deal of money, they are endeavouring to practise it upon the Committee, by keeping this evidence back. They are fighting for a Bill in order not to be sent back into the country without one; they are fighting for no public object whatever, for it is gone; they can give no advantage to the public which they do not now possess. It is impossible, after the evidence which has been gone through, that my learned friends can be in a situation to ask of the Committee to give their sanction to this Bill upon the grounds they put it, when the case was originally opened."

On the thirty-seventh day the concluding speech in favour of the Bill was made by Mr. Adam, in which no new points of interest were evolved. On the thirty-eighth day the proceedings were brought to a close. The following is the Parliamentary record:—

Mercurii, 1° *Die Junii*, 1825.

GENERAL GASCOYNE IN THE CHAIR.

On the previous day the preamble of the Bill was declared to be proved.

The first clause of the Bill, containing the names, &c., of certain parties constituting the Company, was read and agreed to.

The clause, entituled "Company empowered to make Railway from Liverpool to Manchester," was read.

MR. HARRISON.—With respect, sir, to the clause which has been just read, I shall have occasion to address myself to one part of it, which relates to the Waterloo Road. My learned friends must state where they mean to stop. I must know what they mean to do before I propose any amendment.

MR. ADAM.—We mean to begin at one end and go to the other; the clause begins at Liverpool, and states all the places we mean to take in the line.

CHAIRMAN.—At the Prince's Docks?

MR. ADAM.—My learned friend is not instructed by any person at the Liverpool end.

MR. HARRISON.—I beg your pardon, I appear for the Corporation.

MR. ADAM.—We propose to insert the following words at a certain place, "commencing at the east side of the Waterloo Road," after the words "Prince's Docks."

Some discussion took place as to the wording of the amendment, which was at length agreed to.

Mr. Harrison.—I cannot help thinking that my learned friends thought they should have been beat yesterday, or else they would have been ready with their clauses.

Mr. Adam.—Might we not as well have expected, that some little more discussion would have taken place?

The question was put, That the clause intituled, "Company empowered to make Railway from Liverpool to Manchester," amended do stand part of the Bill.

The Committee-room was ordered to be cleared.

After some time the counsel, agents, and parties, were again called in, and informed that the question, That the clause intituled, "Company empowered, &c. as amended, do stand part of the Bill," had been put and negatived.

Mr. Creevey.—Do you go on?

Mr. Adam.—I should certainly wish to take the opinion of the Committee on the next clause.

The clause entituled, "Power to take Lands, &c.," was read.

Chairman.—Are there any amendments?

Mr. Harrison.—There are some, sir.

Chairman.—Are they at all material?

Mr. Harrison.—I object, sir, to the whole clause.

Chairman.—You object to the whole of the clause?

Mr. Harrison.—I object to it on the ground of the inaccuracy of the plans and sections.

Mr. Adam.—I have already argued the validity of the plans and sections.

Mr. Creevey.—You had better take the opinion of the Committee upon the whole clause.

Mr. Harrison.—The amendment is only to strike out some few words from the clause.

The question was put, That the clause entitled, "Power to take Lands, &c.," do stand part of the Bill.

The Committee-room was ordered to be cleared.

After some time the counsel, agents, and parties, were called in and informed, that the question, That the clause intituled, "Power to take Lands, &c.," do stand part of the Bill, had been put and negatived.

Mr. Adam.—Then of course I can give no further trouble: as you have taken out of the Bill those two clauses, I will not trouble you any further, as it would be to take up your time unnecessarily.

Mr. Macdonald.—Having paid some considerable attention to

this inquiry as it has proceeded; for one, I cannot help expressing to the counsel on both sides my approbation of the manner in which this case has been conducted.

CHAIRMAN.—In which sentiments I am sure all the members of the Committee will unite.

MR. HARRISON.—On behalf of all my learned friends and myself, I can only say, it is a great satisfaction to us to hear that our conduct upon this occasion has received your sanction.

"THE OLD ROAD AND THE NEW."

B.

RAILWAY ACCIDENTS AND INSURANCE AGAINST THEM.

THERE can be no doubt that, considering the immense increase in the number of persons who travel, railway trains are a much more safe mode of conveyance than stage-coaches were. An old stage-coachman once gave a definition of the two kinds of accidents, in which there was much wit as well as much truth. He said, "When an accident happens to a stage-coach, why, you are thrown off, and there you are; but, when an accident happens to a train, where are you?" It is perfectly true, that a railway accident is a much more dreadful thing than the overturning of a coach; just for the same reason that a tiger, if let loose, would do more mischief than a cat; and we have, therefore, a greater dread of the one than the other. But it may, without fear of denial, be said, that the engine-driver has much more power over his locomotive than the coachman has over his horses; and that the railway is much better made, better kept, and better adapted to its peculiar traffic, than were the old turnpike-roads. If we have called into action a much more powerful means of locomotion, we have certainly acquired, at the same time, a greater proportionate control over it; and thus, railway accidents being less frequent, are, in the aggregate, not so terrible as those which occurred before railways were constructed.

During the half-year ending 31st December, 1851, the number of passengers on the Railways of the United Kingdom was, in the aggregate, 47,509,392; and of these, 113 were killed, and 264 injured. Therefore, the chances of death or injury to each of these passengers may be thus stated:—

Chances of being killed	1 out of 420,437
„ „ killed or injured	1 out of 126,019

Indeed, it may be said, that there is more danger in walking the streets of a large town, than in travelling by railway.

But an analysis of the circumstances attending these deaths and injuries shows even more clearly the safety of railway travelling. Of the 113 deaths, one was a case of deliberate suicide, for which railway traveling is as little chargeable as water is for its property of drowning people. Again, 33 were trespasses on the line, contrary to all the prohibitions, notices, and cautions, of which it is impossible to suppose they were ignorant. Of the rest, 62 were not, strictly speaking, passengers, but servants of the Companies or contractors; and of that number 32 were killed from their own misconduct, or want of caution. The *bonâ fide* passengers were only 17, and of these eight, or about one-half only, were killed by causes beyond their own control. We annex the official statement of all these cases, a document at once both interesting and instructive.

Again, there exists now a system of insurance against railway accidents, by which their consequences may be alleviated, as far as it is in the power of money to do so. The principle of the system may be understood from the following statement. If every traveller during the second six months of 1851, had paid a penny for every journey into a relief fund, the amount realized would have been £197,955. This would have permitted the payment of £1000 to the representatives of each person killed, and of £250 to each person injured. Each railway traveller pays, on an average, about 1*s.* 8*d.* each journey, so that an additional penny would have secured for these poor sufferers the most incalculable relief. At almost every railway station there can now be purchased single journey assurance-tickets, which, in the event of death by accident, insures to a third-class passenger £200 for one penny; to a second-class passenger, £500 for two-pence; and to a first-class passenger, £1000 for three-pence. During the half-year to which we have referred, the number of such tickets issued by the Railway Passengers' Assurance Company was as follows:—

First class	29,520
Second class	74,016
Third class	133,468
Periodical tickets	2227
Double journey tickets	19,744
	258,975

that is to say, only one passenger out of every 183 had the precaution to insure his life on a railway journey. The whole sum insured is paid in case of death; and where personal injury only is sustained,

compensation, in proportion to the extent of the injury and the amount insured, is made. Periodical tickets are issued to insure £1000—for one month, 5*s.*; three months, 10*s.*; six months, 16*s.*; and twelve months, 20*s.* Arrangements are also made, according to circumstances, for insuring the lives of the persons employed on the lines of railway. We annex a note of the claims made upon this Company during two years,—a document both curious and interesting:—

CLAIMS AND COMPENSATION.

From November, 1849, to October, 1851.

The fatal cases are as follows :—

1. A driver of a ballast-engine crushed near Peterborough, on the 18th October, 1850. Insured for £500. He left a widow and one child.

2. An engine-driver crushed near Campsie Junction, on the 31st October, and so severely injured that he died a week afterwards. Insured for £500. Paid to his widow.

3. An engine-driver killed near Rugby, on the 16th February, 1851. The sum insured, £500, has been paid to the widow, who was left with six children totally unprovided for.

4. An engine-driver killed near Carstairs, on the 13th June, insured for £500. The amount insured has been paid to the widow.

5. A goods guard killed, on the 25th of July, near Glasgow. The amount insured, £200, has been paid to the widow, who was left with two children quite destitute.

6. W. B., a station-master, insured for £200, had his hand crushed at Halifax, on the 10th September. Mortification ensued, and he died in a few days. Payable to the widow.

The cases of personal injury to parties insured with this Company, and the mode in which the claims have been dealt with, will be seen in the following statement :—

Claim 1. W. G. met with an accident at Preston, on the night of the 1st November, 1849. Adjusted by a payment of £7 6*s.*

2. W. F. met with an accident near Perth, on the 29th November. This claim was settled by a payment of £20.

3. J. G. H. hurt in a collision near Manchester, December 31st. His claim was settled by the Company paying, at his request, five guineas to the Manchester Infirmary, the claimant being himself a medical man.

4. J. H. C. met with an accident near Thirsk, on 24th January, 1850. Adjusted by the payment of £31 10*s.*

5. A. S., holder of a first-class single journey insurance ticket, injured by the train running off the rails between Bilsworth and Wolverton, January 28. Settled by a payment of £14 14*s.*

6. G. P., also a passenger by the above train. Settled by a payment of £15.

7. A. N. S. was severely injured, especially in the face and eyes, by the collision on the 13th February, near the Abingdon station. This claim was settled by a payment of £210, the injury to the eyes having proved to be of a permanent character.

8. M. F., holder of a single journey insurance ticket, was also a passenger by the same train. His claim was settled by a payment of £30.

9. T. P. was injured by a collision in the long tunnel on the Leeds and Bradford Railway, on the 18th February. This claim was settled by a payment of £40.

10. C. R. was injured while travelling from Newcastle to Manchester, on the 15th March. The claim was adjusted by the payment of £10.

11. W. A. and his wife, holding insurance tickets for the journey, were passengers by the mail train, which ran into an engine on the siding, on 6th May, near the Belmont station. This claim was adjusted by the payment of £35 as compensation.

12. J. H., an engine-driver, was driving the engine of a goods train on the 25th of May, between Blisworth and Wolverton, which ran off the rails from a bale of cloth having fallen on the line. This claim was adjusted by the payment of 40 guineas, as compensation, the Company defraying his medical and other expenses.

Claims 13 to 18 were made by parties who were travelling by the excursion train on the 3rd July, from Leek and Macclesfield to Liverpool, which, in descending the incline in the tunnel near the latter town, ran against the walls of the station in Lime-street, from the weight of the train being so great that the breaks could not be properly applied.

13. J. G., with his wife and mother-in-law, left Leek, having previously taken second-class single journey insurance tickets. They were all much bruised and otherwise injured. Compensation allowed, £6.

14. E. M., also from Leek, a third-class passenger, was hurt about the head and face. Compensation, £1.

15. T. M. and his wife, employed in the manufacture of silk, third-class passengers, both slightly injured. Compensation afforded, £2.

16. W. S., a passenger from Macclesfield, had insured himself and family, six in number, two of whom received some injuries from the concussion. Compensation, £5 5*s.*

17. T. H. was, in a first-class carriage in the above train, much shaken. Compensation, £6.

[In each of the above cases, this Company paid in addition the fees of the medical attendants.]

18. A second-class passenger from Macclesfield was severely injured about the spine and neck. Not yet adjusted.

19. C. C., hurt while travelling by the mail train, which ran into a wagon near Harrow, on 6th July. The injury appearing to be of a permanent nature, compensation was given to the extent of £425.

20. A. H. injured in the same accident. Compensation, £30 5*s.*

21. J. A. and his wife, holders of single journey insurance tickets, were travelling in a third-class carriage by the same train; he himself escaped with a few bruises but his wife was severely injured. Adjusted by the payment of £15.

From the accident that occurred to the excursion train at Cowlairs, near Glasgow, on the 1st August, when Six persons were deprived of their lives, and many others injured, the following claims have arisen:—

22. J. R. G., hurt about the head and face. Awarded £6.

23. J. C. received a blow in the head. Awarded £4.

24. D. W. was also hurt about the head. Awarded £5.

25. J. S. was injured about the thigh and side. Awarded £3 3*s.*

26. D. S. was severely bruised about the ribs. Awarded £18 10*s.*

27. J. S. was slightly injured. Awarded £2 2*s.*

28. M. S., bruised, and otherwise internally hurt. Awarded £6.

29. E. J. was injured about the chest and side. Awarded £4 4s.

30. J. M. was slightly injured. Awarded £1.

31. A. B. was seriously bruised. Awarded £10.

32. H. M. was severely shaken. Awarded £11.

In most of the above cases the sum awarded is exclusive of the medical expenses incurred by the sufferers, which have been defrayed by this Company, in addition to that of their own medical officer, who promptly visited the injured parties on hearing of the accident.

30. J. W. was thrown from the platform on the 31st of August. Awarded £1.

34. J. S., whilst in the act of cleaning the top of his engine at Edinburgh, on the 15th of September, fell, and injured his arm. Awarded £5.

35. S. G., after completing his journey on the 21st of September, fell from the tender and injured his neck. Awarded £2 10s.

36. W. R., holder of a single journey insurance ticket, was a passenger by the excursion train which came in contact with a horse-box, blown on the line from a siding at Wotton Bassett, on the 20th September. Awarded £12.

37. J. O., in charge of the train which came in contact with a cattle-train at Hatfield, September 21st. The surgeon to the Company was dispatched to Hatfield on the news of the accident being received in town, and rendered him such assistance as was necessary. Awarded £3.

38. J. B. had his knee crushed near Falkirk, on the 30th September. Compensation, £3.

39. R. B. sprained his knee when leaping from the train in a collision in the Woodhead tunnel, on the 1st November. Awarded £1 1s.

40. J. B., severely injured near Glasgow, on the 7th November. Awarded £15.

41. J. P. had his foot severely hurt at Bradford, on the 28th October. Awarded £5.

42. A. K., severely bruised at the London-bridge station, on the 28th November. Compensation, £5.

43. W. K., injured near Glasgow, on the 3rd November. Compensation, £5.

44. G. B., hurt in a collision on the Bristol and Exeter Railway, on the 17th December. Awarded £15.

45. B. C., holding a single journey ticket, hurt in a collision in the Primrose-hill tunnel, 7th December. Compensation, £5.

From the collisions that occurred at Stratford and Brick-lane stations, on the 23rd December, the following claims have arisen:—

46. W. W., slightly injured. Awarded £1 1s.

47. T. T. received a severe blow on the head. Compensation, £5 5s.

48. J. E. B. had severe contusions of both legs. Awarded £15 15s.

49. J. R. H., severely bruised. Awarded £4 2s. 6d.

50. G. R. was much hurt. Awarded £25.

51. H. B., internally injured while travelling from York to Normanton, on the 9th December. Compensation, £50.

52. J. A., seriously injured at Normanton, on the 5th of January, 1851. Awarded £20.

53. M. H. had his hand crushed near Glasgow, on the 19th. Compensation, £5 5s

54. J. V., injured near Hartlepool, 26th January. Awarded £2.

55. J. W., fractured leg, near Huddersfield, February 6th. Awarded £6.

56. A. A., severely hurt in the collision near Alderley, February 8th. Awarded £10.

57 T. L. was stunned by his head coming in contact with the panel of the carriage in the same collision; and although able to resume his journey, was after a short time confined to his bed for upwards of a month by concussion of the brain. Awarded £120.

58. R. G. severely scalded by bursting of a tube in the engine, at Falkirk, February 26th. Awarded £38.

59. T. G., injured at Heaton Norris station, February 19th. Awarded £4 10*s.*

60. J. H., hurt near Winchburgh station, February 27th. Awarded £2.

61. T. F., hurt at Glasgow, Feb. 3rd. Awarded £2 14*s.* 6*d.*

62. H. M. H. was injured in a collision near Derby, 3rd March. Awarded £3 3*s.*

63. J. P., hurt at Arbroath, March 5th. Awarded £2.

64. B. A., severely injured on the foot, near Wolverton, March 17th. Awarded £20.

66. G. H. was injured at Castle Cary station, April 7th. Awarded £7.

67. J. D., hurt at Dumfries, April 19th. Awarded £1 15*s.*

68. W. K. was injured near Glasgow, April 23rd. Awarded £1.

In the fearful accident in the Sutton tunnel, near Frodsham, where six persons were killed, and many injured, the surgeon of the Company was at once dispatched to render assistance to those who might have taken insurance tickets. None of the unfortunate persons killed had taken this precaution, and the only claim on the Company is,—

69. H. C. H., who received a compound fracture of the leg. Awarded £400.

70. J. F. R. received an injury on the leg at Hanwell, Dec. 23rd. Awarded £5 5*s.*

71. J. S. received an injury at Glasgow, May 29th. Awarded £2 2*s.*

72. W. E. had his arm broken in the collision which took place at the Clay Cross station on the 20th May. Awarded £200.

73. W. E., hurt at Firsby station, on February 5th. Awarded £2.

74. H. Mc C. received an injury to his back at Nottingham station, on June 24th. Awarded £10.

From the collision which occurred at Forfar station on the 24th June, the following claims arose :—

75. N. P., holder of third-class single journey ticket, was hurt on the forehead and eye. Compensation, £2 10*s.*

76, J. S. and wife, holders of third-class single journey tickets, were bruised and injured. Compensation, £5.

77. G. R., holder of first-class single journey ticket, received several severe injuries. Compensation, £25.

78. A. B., holder of a third-class single journey ticket, received a severe cut on the forehead. Compensation, £5.

79. T. J., holder of a first-class single journey ticket, received a fracture of the jaw. Compensation, £25.

80. W. K., holder of a first-class single journey ticket, sustained some internal injuries. Compensation, £20.

81. R. W., holder of a second-class single journey ticket, received a deep cut in the forehead. Compensation, £3 3*s.*

Compensation was awarded, in the above cases, by the surgeon to the Company, who visited the several parties immediately after the accident.

82. Mr. Mc A., bruised about the head and neck. Compensation, £1.

83. J. D. received contusions on the right shoulder and breast. Compensation, £3 5*s.*

84. W. G. received several severe sprains. Compensation, £4 4*s.*

85. M. S. received a severe contusion of the face. Awarded £10.

86. B. R. received severe contusions of the body. Compensation, £6 10*s.*

87. J. B. and his wife were much bruised and shaken. Compensation, £6 10*s.*

88. A. G., slightly injured. Compensation, £2.

89. M. C. W. was severely injured on the right eye. Compensation,

90. A. L. slightly injured. Compensation, 10*s.*

91. G. L., received injuries on the head and foot. Compensation, £4.

92. A. G., slightly injured. Compensation, £1.

94. R. C., injured on the right arm. Awarded £2 10*s.*

95. T. S. received several severe injuries in the collision between Dumfries and Kilmarnock, July 5th. Awarded £10.

96. W. H., injured on the right ancle joint, in the same accident. Awarded £2 18*s.*

97. J. F. received a contused wound on the right eye, in the collision at the Johnstone station, on July 5th. Awarded £4 4*s.*

98. W. J. was severely injured, near Tetbury, on July 8th. Awarded £100.

99. L. L., injured at Ayr, on the 18th July. Awarded £1 10*s.*

100. W. B. was severely injured in the collision near Sheffield, on August 6th. Compensation, £10 10*s.*

In the accidents on the London and South Western Railway, that occurred on July 28th, and August 8th, none of the parties injured held single journey insurance tickets, as the Directors will not allow them to be issued on their line; the only claim, therefore, was—

101. J. G. R., holder of a periodical ticket, who received a slight concussion of the brain. Awarded £60.

102. E. R., holder of a periodical ticket, was severely bruised by a collision, which occurred at Normanton station, on the 7th September, 1851. Awarded £5.

103. Mrs. R. also received a severe contusion of the thigh. Awarded £10.

104. C. P., holder of a periodical ticket, received an injury to his breast, at North Dean station, on Sept. 2. Awarded £5.

105. J. P. and wife, holders of periodical tickets, received several severe bruises, in the collision which took place at the Bicester station, on September 6th, 1851. Awarded £150.

The following claims have arisen from the collision which took place near the Hornsey station, on September 8th:—

106. The Rev. W. S., holder of a third-class single journey ticket, received a severe concussion of the spine. Awarded £150.

107. H. B., holder of a third-class single journey ticket, received internal injuries, Awarded £3 3*s.*

108. J. D., holder of a third-class single journey ticket, received a bad lacerated wound of the right cheek. Awarded £10.

109. H. R., wife, and neice, holders of second-class single journey tickets, received several injuries. Awarded £15.

110. R. M., holder of a third-class single journey ticket, received several severe injuries. Awarded £15.

111. H. M., wife, and daughter, holders of first-class single journey tickets, were each slightly injured. Awarded £15 15*s.*

112. J. G. K., holder of a second-class single journey ticket, was severely bruised about the face. Awarded £12.

113. A. D. and wife, holders of third-class single journey tickets, received some slight injuries. Awarded 30*s*.

114. Mrs. R., severely bruised. Awarded £3. 3*s*.

The following claims have arisen from the collision which took place at Kirtle Bridge on the 11th of September:—

115. M. C., holder of a first-class single journey ticket, received a contusion on the leg. Awarded £42.

116. A. K., and wife, holders of second-class single journey tickets, received several severe bruises. Awarded £7 7*s*.

117. G. T., holder of a third-class single journey ticket, was severely bruised about the head and face. Awarded £8.

118. J. A. S., holder of a third-class single journey ticket, received several cuts and bruises. Awarded £2 2*s*.

119. J. M., holder of a third-class single journey ticket, received a contusion on the leg. Awerded £2 2*s*.

120. W. B., holder of a third-class single journey ticket, was also injured on the leg. Awarded £2 10*s*.

121. W. J., holder of a second-class single journey ticket, was severely bruised Awarded £10.

122. P. Mc L., holder of a periodical ticket, was seriously injured, by falling from the seat of the carriage, in a collision at Edinburgh, on the 27th September. Awarded £50.

123. D. K., holder of a periodical ticket, had the bones of his nose broken, in the collision which took place at Eckington station, on October 1st. Awarded £80.

124. J. H., holder of a periodical ticket, also received a severe injury. Awarded £15.

125. G. D., holder of a periodical ticket, received a concussion of the spine, in the collision which took place near Kirkstead station, on the 17th October. Awarded £15.

126. J. R., holder of a periodical ticket, received a contusion of the side, near Syston, on November 8th. Compensation, £11 11*s*.

128. J. C., holder of a periodical ticket, received injuries to his knees in a collision near Manchester, on the 17th November, 1851. Awarded £4 4*s*.

129. J. D., holder of a periodical ticket, received injuries whilst travelling to Edinburgh, on the 19th November. Not yet adjusted.

The following claims have arisen from the collision which took place at Weedon on the 22nd November.

130. R. K., holder of a second-class single journey ticket, received several severe injuries about the head. Awarded £75.

131. H. P. B. was severely bruised. Awarded £21.

132. J. D. B., holder of a periodical ticket, had his upper lip cut through. Awarded £10 10*s*.

133. W. B., holder of a second-class single journey ticket, received an injury to his knee and ancle. Awarded £10 10*s*.

134. Mrs. T., holder of a second-class single journey ticket, was slightly injured. Awarded £1 1*s*.

136. S. B., holder of a second-class single journey ticket, was injured in consequence of the train coming into collision with a luggage-train, between Derby and Burton, on December 17th. Awarded £10.

137. W. G., holder of a periodical ticket, received an injury to his shoulder, at Perth, on December 22nd. Awarded £20.

138. J. C., holder of a second-class single journey ticket, was slightly injured whilst travelling between St. Helens and Newton, on the 22nd of November. Compensation, £2 2*s*.

139. C. M., holder of a periodical ticket, was injured whilst travelling between Preston and Manchester, on the 4th of November. Awarded £2 2*s*.

Another Company,—the Accidental Death Insurance Company,—insures against accidents of all kinds, inclusive of those on railways. They issue annual policies, at various rates, according to the nature of the occupation of the persons insuring. The rates for railway servants are as follows, and give a very good idea of the comparative risks run by railway officials.

OCCUPATION.	Rates for £100 on Accidental Death.	Rate for £100 on Accidental Death, and £1 per week Compensation in case of serious injury.
Guards and Breaksmen	40s.	50s.
Enginemen and Stokers	20s.	30s.
Platelayers	15s.	25s.
Porters, Policemen, Switchmen, Inspectors, Gatekeepers	10s.	20s.
Labourers.........................	7s. 6d.	17s. 6d.
Station Masters, and Clerks employed as Station Masters	7s. 6d.	17s. 6d.
Secretaries, Clerks employed in Offices, &c.	2s. 6d.	12s.

It is, doubtless, impossible that railroads can ever be so perfectly managed that accidents will not sometimes occur; but their number is gradually becoming greatly diminished, and they are divested of many of their evil consequences by the existence of such Insurance Companies.

RETURN of the Number and Nature of the Accidents and the Injuries to Life and Limb which have occurred on the Railways in Great Britain and Ireland, during the Half-year ending 31*st December*, 1851, *together with the Number of Passengers conveyed during the same period.—(From a Parliamentary Paper, dated* 10*th May*, 1852.)

Date of Accident.	Name of Railway.	Number of Persons		Number of Passengers carried during the Half-year ending 31st Dec. 1851.	Nature and Cause of Accident, taken from the Reports made to the Railway Department by the Railway Companies.
		Killed.	Injured.		
1851. 7 Oct.	Aberdeen	nil	nil	261,012	A passenger train divided while passing the junction points at Glasterlaw, the engine tender and van taking one line, and the carriages the other; no person injured.
18 Nov.	ditto	1	...	...	John M'Kenzie, carter, while waiting at a station for some goods, incautiously attempted to cross the line in front of an approaching train, and was run over.
	Ambergate, Nottingham and Boston, and Eastern Junction............	...	...	57,175	
	Ardrossan	nil	nil	43,597½	
	Bedford	...	...	...	*See* "London and North Western."
	Belfast and Ballymena...............	...	...	222,980	
	Belfast and County Down	...	...	212,550	
	Birkenhead, Lancashire, and Cheshire Junction ...	...	...	313,560	
	Bodmin and Wadebridge...............	...	...	1,234	
14 July	Bristol and Exeter.	...	...	379,759	Tire of one of the leading wheels of a second-class carriage gave way; no person injured.
30 Oct.	ditto	1	...	...	Mr. John Fisher, a passenger, incautiously alighting from a carriage in motion, at the Yatton station, fell between the train and the platform, receiving such severe injuries that death ensued.
1 July	Caledonian	...	1	902,812	Jane Little, the child of a servant of the Company, knocked down by an engine as she was crossing the line.
18 July	ditto	1	...	...	Alexander Topping, guard, walking along the top of a train in motion (contrary to rule), came in contact with a bridge, and was killed.
11 Sept.	ditto	...	...	...	Passenger train came into collision with an engine which was shunting at the Kirtlebridge station.
9 Oct.	ditto	1	...	...	Passenger jumped from a train in motion, and was killed.
1 Nov.	ditto	...	1	...	Passenger getting out of a train in motion, fell, and wheels of a luggage van passed over his ankle.
3 Nov.	ditto	1	...	...	John Scott, pointsman, in the act of shifting the points at the Clelland Branch, lost his balance and fell under the wheels of a mineral train.
6 Nov.	ditto	1	...	...	Michael Benson, coke-filler, run over at a station by an engine which was being moved slowly forward to receive a supply of coke.

Date of Accident.	Name of Railway.	Number of Persons Killed.	Number of Persons Injured.	Number of Passengers carried during the Half-year ending 31st Dec. 1851.	Nature and Cause of Accident, taken from the Reports made to the Railway Department by the Railway Companies.
1851. 6 Nov.	Caledonian, *contd.*	1	...	...	Trespasser run over by a night mail train.
28 Nov.	ditto	1	...	...	William Dick, breaksman of a mineral train, thrown off from one of the waggons which had got off the rails when passing the Whifflat station.
13 Dec.	ditto	...	1	...	John Logg, lampman, in service of the Company, jumping from a train in motion, fell, and wheels passed over both legs.
31 Dec.	ditto	...	1	...	Thomas Brawnlee, breaksman, jumping from a train in motion, fell, and wheels passed over his arm.
	Caledonian and Dumbartonshire Junction...........	...	...	138,950	
8 Sept.	Chester and Holyhead................	1	...	273,689	James Webster, engine driver, accidentally fell from an engine, and was killed.
6 Sept.	ditto	1	...	...	Henry Hughes, platelayer, standing too close to a passing train at the Belmont station, had his foot so severely crushed that death ensued.
20 Sept.	ditto	1	...	...	J. Reid, platelayer, run over while asleep on the Mold line.
27 Sept.	ditto	...	1	...	Mr. R. Jones, cattle dealer, incautiously sitting on the top rail of a cattle waggon, came in contact with a bridge and had his skull fractured.
5 Nov.	ditto	1	...	...	Edward Cunningham, breaksman, fell from a break, and was run over by a portion of the train.
15 Nov.	ditto	1	...	...	Richard Owen, a lad 10 or 12 years old, run over while trespassing on the line.
22 Nov.	ditto	1	...	...	Edward Evans, servant of the Company, knocked down by a train.
2 Dec.	ditto	1	...	...	Trespasser run over in the Belmont Tunnel.
20 Dec.	ditto	1	...	...	David Kelly, engine driver of a goods train, but had been standing on the engine of a passenger train, and getting off just as it was starting, fell, and was run over.
27 Dec.	ditto	...	1	...	Servant of contractor fell under the wheels of a horse waggon which he was driving, and had both legs broken.
	Cockermouth and Workington.......	...	...	31,424	
	Cork and Bandon...	...	...	29,858	
	Cork, Blackrock, and Passage	...	...	240,300	
	Dowlais	...	...	3,468½	
21 Oct.	Dublin and Belfast Junction...........	1	...	56,839	Woman run over and killed while trespassing.
	Dublin and Drogheda	...	...	274,136	
16 July	Dublin and Kingstown	...	1	981,250	Passenger getting out of train in motion came in contact with a pillar, and was thrown down.
	Dundalk and Enniskillen............	...	...	27,407	
	Dundee and Arbroath................	...	...	242,219	
22 July	Dundee and Perth and Aberdeen Railway Junction	1	...	158,344	Mr. James Pennycuick, in attempting to save his dog from being run over, was struck by the buffer beam of an engine, and killed.

Date of Accident.	Name of Railway.	Number of Persons Killed.	Number of Persons Injured.	Number of Passengers carried during the Half-year ending 31st Dec. 1851.	Nature and Cause of Accident, taken from the Reports made to the Railway Department by the Railway Companies.
1851. 8 Oct.	East and West India Docks and Birmingham Junction	1	...	1,444,538	George Baker, engine driver, in the service of the London and North Western Railway Company, having climbed to the top of a carriage, for what purpose is not known, came in contact with a girder bridge, and was killed.
	East Anglian.........	...	...	105,017	
6 Aug.	Eastern Counties...	1	...	2,003,268	James Day, porter, crushed between buffers while shunting carriages.
10 Sept.	ditto	1	...	...	Passenger incautiously standing in a siding was crushed between the permanent buffers and a tender, which was being backed into the siding.
7 Oct.	ditto	1	...	...	William Leaver, servant of Telegraph Company, run over and killed by a train before which he had incautiously stepped.
22 Oct.	ditto	1	...	...	William Stone, engine driver, imprudently crossing among some trucks, was crushed between them and an engine.
4 Nov.	ditto	1	...	...	Trespasser found dead upon the line.
30 Nov.	ditto	1	...	...	Passenger jumped from a train in motion, fell, and was run over.
24 Dec.	ditto	...	1	...	John Barnard, fireman, having occasion to mount the side of the tender of a train in motion, came in contact with a bridge, and was thrown under the train; legs crushed.
	Eastern Union......	...	...	258,868	
14 Aug.	East Lancashire ...	...	1	1,130,336½	David Entwisle, engine driver, injured in consequence of running his train into a bridge under repair, not being able to stop in time.
13 Aug.	ditto	1	...	...	Trespasser run over while walking along the line.
24 Aug.	ditto	1	...	...	Thomas Walker run over while crossing the line at a crossing.
9 Sept.	ditto	1	...	...	Passenger attempting to get into a train in motion fell between the carriages and the platform, and was killed.
20 Sept.	ditto	1	...	...	Robert Halstead, porter, attempting to get upon a train in motion, fell, and was run over.
20 Oct.	ditto	...	7	...	Six passengers and the guard injured, in consequence of part of the train running off the line at the junction of the Patricroft branch, near Clifton station.
4 Dec.	ditto	...	1	...	One passenger slightly cut on the forehead by an express train running into a goods train at the Radcliffe station. Weather so thick that the driver could not see signals. Fog-signals had been placed on the rails, but were passed over without any explosion being heard.
6 Dec.	ditto	1	...	...	John Fletcher, watchman, crushed between waggons while shunting.
15 Dec.	ditto	...	1	...	Passenger preparing to alight from the train before it had stopped, was observed leaning out of the window and having hold of the handle; the door flew open and he fell out, fracturing his skull, and receiving other injuries.

Date of Accident.	Name of Railway.	Number of Persons Killed.	Number of Persons Injured.	Number of Passengers carried during the Half-year ending 31st Dec. 1851.	Nature and Cause of Accident, taken from the Reports made to the Railway Department by the Railway Companies.
1851.					
	Edinburgh and Glasgow	...	...	560,745	
1 July	Edinburgh, Perth, and Dundee	...	1	668,620	James Steven, gatekeeper, slipped from the footboard of an engine on which he was riding, and had his foot bruised by the wheels of the tender.
13 Sept.	ditto	...	1	...	John Buncle, porter, incautiously stepping upon the rope used on an incline, was thrown down, and had his leg broken.
22 Oct.	ditto	1	...	...	Adam Drysdale, horse driver, in the service of Messrs. Howey and Co., while unhooking the chain from a truck which he was moving at the Dunfermline station, fell, and was run over.
	Exeter and Crediton	...	...	61,305	
	Fleetwood, Preston, and West Riding Junction..........	...	...	31,869	
25 Nov.	Furness	2	...	46,247	Thomas Lewis and William Poole, labourers on the line, run over and killed while walking homewards at night.
4 July	Glasgow and South-Western	1	...	620,431	Guard of a goods train run over by a truck.
5 July	ditto	...	1	...	Passenger cut in the face, in consequence of a passenger train running into an excursion train which had become disabled.
13 Aug.	ditto	1	...	...	Archibald Wallace, fireman, fell while sorting waggons, and was run over.
13 Nov.	ditto	1	...	...	Trespasser run over at night.
	Glasgow, Paisley, and Greenock.....	...	...	97,007	One month only; the remaining five included in Caledonian traffic.
2 July	Great Northern......	1	...	805,998	Charles Lichford, farmer, crossing the line at the level crossing, West Street, Boston station, was run over by a train, and killed.
8 Sept.	ditto	...	50	...	Fifty passengers injured, in consequence of an excursion train running into a Boston passenger train at the Hornsey station.
4 Oct.	ditto	1	...	...	Jacob Mason, plate-layer, supposed to have fallen under an engine at the Boston station.
11 Oct.	ditto	1	...	...	Trespasser, endeavouring to cross the rails at the Boston station, between some carriages, was crushed by them.
17 Oct.	ditto	...	1	...	Robert Hopkins, fireman, injured on the head, in consequence of a collision between a passenger train and an empty coal train at Kirkstead.
6 Nov.	ditto	...	1	...	Edward King, porter, while uncoupling a truck, had his arm crushed and broken between the buffers.
10 Dec.	ditto	...	1	...	William Lear, shunter, foot crushed in attempting to ride upon the step of an engine in motion.
14 Aug.	Great Southern and Western (Ireland)	1	...	250,554½	Jeremiah Murphy, watchman, run over while asleep on the line.
18 Oct.	ditto	...	1	...	Passenger jumping from a train in motion had his leg broken and head fractured.

Date of Accident.	Name of Railway.	Number of Persons Killed.	Number of Persons Injured.	Number of Passengers carried during the Half-year ending 31st Dec. 1851.	Nature and Cause of Accident, taken from the Reports made to the Railway Department by the Railway Companies.
1851. 10 Aug.	Great Western	...	10	1,864,114½	Ten passengers injured. An excursion train having stopped at Fox's Wood, near Bristol, owing to the pump of the engine being choked, was run into by a pilot engine.
24 Sept.	ditto	1	...	...	Workman run over and killed while asleep on the line.
3 Nov.	ditto	1	...	...	David Timbrell, 84 years old, deaf, and nearly blind, run over and killed while attempting to cross the line at a foot crossing.
4 Dec.	ditto	nil	nil	...	Some trucks having been detached from a train, in order to enable a portion of it to ascend the incline near the Tetbury-road station, and not being properly secured, ran back, and came in collision with an advancing Parliamentary train, causing the breaking of the buffer beam of the engine, and the destruction of the trucks.
16 Dec.	ditto	1	...	...	Servant of the Electric Telegraph Company run over by an express train.
	Irish, South Eastern	...	...	27,097	
26 Nov.	Kendal and Windermere	1	...	55,682	Anthony Stringer, porter and guard, slipped off the break while passing a station, and was killed.
11 Aug.	Lancashire and Yorkshire..........	1	...	3,198,824	Trespasser run over by a goods train.
12 Sept.	ditto	1	...	...	Harrison Hardy, porter, crushed between buffers while coupling waggons.
22 Oct.	ditto	...	1	...	One passenger injured in consequence of a collision on the Blackburn Railway, in the Cranberry Moss Tunnel, by a passenger train overtaking and running into a goods train.
4 Nov.	ditto	...	7	...	Collision between a passenger train and a coal train, at Bullfield, near Bolton, whereby seven passengers were injured.
10 Nov.	ditto	...	1	...	Trespasser run over; leg fractured.
13 Nov.	ditto	1	...	...	Nelson Hilton, servant of Company, crushed between an engine and a waggon, which he was pushing along the rails.
11 July	Lancashire and Yorkshire, and East Lancashire (Liverpool and Bootle Joint Stations)................	1	...	...	John Taylor, servant of Company, fell from a train in motion, and was killed.
8 Nov.	Lancaster and Carlisle	1	...	250,329	Trespasser run over and killed.
12 Nov.	ditto	1	...	...	Richard Cutler, an old deaf man, crossing the line at a public footpath in front of a train, was run over and killed.
	Leeds Northern.....	...	...	166,525	
	Liverpool, Crosby, and Southport...	...	...	329,609	
	Llanelly Railway and Dock Company	...	...	10,229	

Date of Accident.	Name of Railway.	Number of Persons		Number of Passengers carried during the Half-year ending 31st Dec. 1851.	Nature and Cause of Accident, taken from the Reports made to the Railway Department by the Railway Companies.
		Killed.	Injured.		
1851. 24 Oct.	London and Blackwall	1	...	2,018,193	James Powell, in the service of the East and West India Docks and Birmingham Junction Railway Company, leaving a carriage in motion, fell, and was run over.
10 Aug.	London and North Western............	...	...	4,466,698	A third-class carriage full of luggage caught fire; no injury sustained by any person.
6 Sept.	ditto	6	20	...	Six passengers killed and 20 injured, in consequence of an excursion train running off the line at the points at the Bicester station of the Buckinghamshire Railway.
22 Nov.	ditto	1	21	...	One passenger killed, and twenty-one injured by a collision at the Weedon station. A passenger train while waiting at the platform at Weedon, to allow a coal train, which stood in front of it, to be shunted out of the way, was run into from behind by a special cattle train, and being thrown violently against the coal train, which was then moving back in the opposite direction in order to cross to the other line, was again struck by the advancing engine of the cattle train.
23 Dec.	ditto	...	2	...	Two passengers injured by a collision between two trains, at Huyton.
25 July	London and South Western............	1	...	2,628,087	—— Self, porter, improperly riding on the step of a carriage, came in contact with the parapet of a bridge, and was killed.
1 Aug.	ditto	1	...	...	William Masey, contractor's labourer, incautiously passing from the down to the up line while trains were passing, was run over and killed.
7 Aug.	ditto	...	15	...	Fifteen passengers injured by a collision between two trains at the Vauxhall station.
8 Aug.	ditto	...	4	...	Four passengers injured by a carriage being overturned, in consequence of the train running off the line.
27 Aug.	ditto	1	...	...	—— Dawkins, gateman, not opening the gates in time, was knocked down by an engine and killed.
27 Sept.	ditto	1	...	...	A train having been let through the wrong points at Nine Elms, ran against a truck, which passed over and killed —— Matthew, a carter in the service of the Company.
18 Oct.	ditto	...	3	...	Passenger train ran into a siding at Dorchester, owing to the points not being properly open, and coming into collision with some trucks caused three persons to be injured.
28 Nov.	ditto	1	...	...	Thomas Fielder, porter, crushed between buffers while crossing between waggons.
13 Dec.	ditto	...	1	...	Passenger getting out of a carriage in motion, fell, and broke his thigh.
5 July	London, Brighton, and South Coast	...	...	2,133,362	Engine of a passenger train from Epsom ran off the line.
4 Oct.	ditto	1	...	...	Trespasser run over.

Date of Accident.	Name of Railway.	Number of Persons		Number of Passengers carried during the Half-year ending 31st Dec. 1851.	Nature and Cause of Accident, taken from the Reports made to the Railway Department by the Railway Companies.
		Killed.	Injured.		
1851. 30 Oct.	London, Brighton, and South Coast, *contd.*	...	1	...	Passenger stepping from a train in motion, fell, and injured her arm, since amputated.
17 Nov.	ditto	...	1	...	Robert Stather, fireman, endeavouring to unhook a pilot-engine from the train-engine, fell, and was severely injured by the latter; leg afterwards amputated.
27 Nov.	ditto	1	2	...	Collision near the Ford station at the bridge over the river Arun, by a passenger train running into a goods train. The engine of the passenger train struck the goods train, and glancing off, went over the embankment, dragging the carriages after it. Two passengers injured, and the fireman of the passenger train so severely hurt that he died a few days afterwards. The engine-driver immediately after the accident attempted to commit suicide by cutting his throat, and then leaping into the river, from which he was dragged by the guard.
	Londonderry and Enniskillen	...	...	50,710	
	Manchester, Buxton, Matlock, and Midlands Junction	...	...	47,995	
21 July	Manchester, Sheffield and Lincolnshire	...	1	1,275,558	Joseph Kenyon, porter at Ashton station, while holding the points to shunt a train, had his ankle injured by the break lever of a waggon striking it.
6 Aug.	ditto	...	16	...	A Great Northern Company's train run into by a goods train near Aston, whereby sixteen passengers were injured.
8 Oct.	ditto	1	...	...	Edward Challender run over and killed while crossing the line at Kiveton Park station.
15 Oct.	ditto	1	...	...	Edward Clare, breaksman, walking backwards by the side of a train, fell, and received such severe injuries by the waggons passing over him that death ensued.
16 Oct.	ditto	1	...	...	Edward Holt, platelayer, attempting to get from one waggon to another while the train was in motion, fell, and was run over.
	Manchester, South Junction, and Altrincham	...	...	503,735½	
	Maryport and Carlisle.................	...	...	75,023	
1 July	Midland...............	1	...	3,310,791	Joseph Foster, platelayer, run over while asleep on the line.
7 July	ditto	1	...	...	Trespasser persisted in crossing the line in front of a train, and was run over.
10 July	ditto	1	...	...	A boy, 11 or 12 years of age, trespassing on the line, fell asleep, and was run over by some waggons drawn by horses.
10 July	ditto	...	1	...	Child, 7 years of age, fell out from the carriage door of a train proceeding from Rotherham to Sheffield; is recovering.

Date of Accident.	Name of Railway.	Number of Persons Killed.	Number of Persons Injured.	Number of Passengers carried during the Half-year ending 31st Dec. 1851.	Nature and Cause of Accident, taken from the Reports made to the Railway Department by the Railway Companies.
1851. 15 July	Midland, *contd.* ...	...	1	...	Platelayer, while endeavouring to get out of the way, was struck by a coal train, and severely injured.
19 July	ditto	1	...	...	An old man (trespasser), walking along the line, was run over and killed.
24 July	ditto	...	9	...	Passenger train ran into a goods train at the Newlay station, injuring nine passengers.
6 Aug.	ditto	1	...	...	Boy trespassing, and standing on the buffers of a coal waggon, fell off, and was run over.
18 Aug.	ditto	1	...	...	Passenger, intending to travel by a Parliamentary train which was then approaching, fell from the platform, being in a state of intoxication, and was run over.
25 Aug.	ditto	...	1	...	Boy who had come with a cart for coals to the Keighley station, crept under a waggon for shelter during a shower of rain; a goods train shunting at the time came in contact with the waggon, the wheels of which passed over and cut off one of his legs.
26 Aug.	ditto	1	...	...	Boy trespassing under a train was run over and killed.
28 Aug.	ditto	1	1	...	Two passengers jumped from an excursion train in motion at the Wingfield station; one was killed, and the other seriously injured.
7 Sept.	ditto	...	3	...	Three passengers injured by a collision between two trains at the Normanton station, caused by the misconduct of one of the drivers in running his train into the station at an excessive speed.
5 Sept.	ditto	...	1	...	Boy trespassing among waggons at a siding, was run over; face bruised, and arm so much injured as to require amputation.
6 Sept.	ditto	...	1	...	D. Workman, fireman, accidentally fell from a train; head and foot cut.
10 Sept.	ditto	1	9	...	John Taylor, fireman of passenger train, killed, and nine passengers injured in consequence of the passenger train running into some goods waggons, near the Mansfield junction.
12 Sept.	ditto	...	1	...	John Gillard, platelayer, run over while asleep on the line; recovery doubtful.
13 Sept.	ditto	1	...	...	Suicide. A person in a fit of insanity placed his neck across the rails, and had his head cut off by a train.
30 Sept.	ditto	...	1	...	Rountree Farrer, platelayer, run over while working on the line; leg crushed, and afterwards amputated.
1 Oct.	ditto	...	4	...	Four passengers injured in consequence of the train by which they were travelling running into a mineral train at the Eckington station.
1 Oct.	ditto	1	...	...	Dawson Fieldhouse, waggon inspector, crushed between buffers while uncoupling waggons.

Date of Accident.	Name of Railway.	Number of Persons Killed.	Number of Persons Injured.	Number of Passengers carried during the Half-year ending 31st Dec. 1851.	Nature and Cause of Accident, taken from the Reports made to the Railway Department by the Railway Companies.
1851. 9 Oct.	Midland, *contd.* ...	1	...	...	David Storer, goods guard, crushed between buffers while coupling an engine to a mineral train.
13 Oct.	ditto	1	...	...	Passenger getting out of a carriage at the Countesthorpe station, on the wrong side, owing to the guard being unable to open the proper door, was struck by a train, and killed.
3 Nov.	ditto	...	1	...	—— Hardy, a boy aged 15, run over while trespassing. Leg cut off.
18 Nov.	ditto	...	1	...	W. Mann, son of a porter in the Company's service, standing on the line looking at a train, was knocked down by the engine of another train, the wheels of which cut off his left hand.
20 Nov.	ditto	...	1	...	Richard Dunthorn, fireman, crushed between waggons while shunting them.
6 Dec.	ditto	1	...	...	M. Westmoreland, platelayer, run over by a train on one line of rails while making signals to a train on the other line.
8 Dec.	ditto	1	...	...	Trespasser run over while lying on the rails.
10 Dec.	ditto	...	1	...	William Johnson, pointsman, while shunting a waggon fell under the wheels, in consequence of the defective state of the break apparatus. Head cut, and side and back crushed.
17 Dec.	ditto	...	2	...	Two passengers injured in consequence of the mail train running into a disabled engine, near the Wellington station.
29 Dec.	ditto	...	1	...	W. Radford, porter, fell off a carriage while shunting a train, and wheels passed over and severely injured his feet.
11 July.	Midland Great Western (Ireland)	1	...	150,529	John Mahon, policeman, while opening gates, which were closed (against rules) across the railway, was struck by an engine and killed.
11 Aug.	ditto	...	1	...	James Callaghan, crushed between the buffers while hooking on a waggon to a goods train, and seriously injured.
30 Oct.	ditto	1	...	...	John Mullins, passenger, attempting to get over the waggon in which he was, to recover his hat, which had been blown off, fell on his head, and was killed.
1 Dec.	ditto	nil	nil	...	Contractor, with a train of ballast waggons, passing the Ballinasloe station, ran off into a siding, owing to the frost preventing the self-acting points from acting.
	Mold	...	...	41,633	
	Monkland Railways	...	...	100,525	
30 Sept.	Monmouthshire Railway and Canal Company.	...	1	68,820	Trespasser injured by carriages running over her foot while she was picking up a coal on the railway.
3 July.	Newcastle and Carlisle	1	...	300,818	Jeremiah Fisher, said to be imbecile, stepped on the line in front of an engine, and was killed.
3 Aug.	ditto	...	12	...	Twelve passengers injured in consequence of part of a train having got off the line near Haltwhistle.

Date of Accident.	Name of Railway.	Number of Persons Killed.	Number of Persons Injured.	Number of Passengers carried during the Half-year ending 31st Dec. 1851.	Nature and Cause of Accident, taken from the Reports made to the Railway Department by the Railway Companies.
1851. 3 Nov.	Newcastle and Carlisle, *contd.*	1	...	...	George Kennedy, breaksman, supposed to have fallen from his train, and to have been run over by it, or the following train.
19 July.	Newmarket	...	1	22,930	John Disbury, bricklayer, in service of Company, alighting from a carriage in motion, fell, and one of the wheels passed over his foot.
8 Sept.	ditto	1	...	...	William Skipper, gatekeeper, rushed on to the line in front of a train, and was run over and killed.
	Newry, Warrenpoint, and Rostrevor	...	...	88,429	
27 Nov.	North British........	...	1	690,460	Passenger, stepping from a train in motion, fell, and had his right leg broken and left foot much bruised.
	North Devon	...	...	no pasngrs	
	North Staffordshire	...	...	526,172	
	North Union........	...	...	...	For passengers conveyed, *see* "London and North Western," and "Lancashire and Yorkshire."
12 July.	ditto	1	...	...	John Gregson, breaksman, passing between two waggons, was crushed between buffers.
12 Aug.	ditto	1	...	...	Richard Wearing, trespassing on the line, was crushed between buffers of a coal waggon and a coal cart.
	North Western......	...	...	105,506	
	St. Helen's Canal and Railway Company	...	...	131,498	
4 Oct.	Scottish Central ...	...	1	302,602	Passenger jumped from a train in motion at the Bannockburn station, fell, and wheels passed over and broke his leg.
	Scottish Midland Junction	...	...	114,733	
	Shrewsbury and Birmingham......	...	...	229,131	
	Shrewsbury and Chester	...	...	179,521	
	Shropshire Union Railways and Canal Company ..	...	...	289,264	
28 Aug.	South Devon	...	1	307,012	Female passenger in a third-class carriage had her arm injured while closing the door.
19 Nov.	ditto	...	1	...	—— Richards, policeman, crushed between two trucks at the Star Cross station, and severely bruised.
14 July.	South Eastern	...	1	2,587,568	Benjamin Evans, servant of Company, was turning an engine on a turn-table, when another engine accidentally struck the buffer of his engine, causing the handle of the windlass to be forced out of his hand, breaking both his arms, and injuring his head.
	Greenwich Branch	...	...	1,171,946	
4 Aug.	ditto	1	...	...	John Taylor, employed on the line, attempting to jump on a ballast train in motion, fell, and was run over.
5 Aug.	ditto	...	1	...	Charles Kimber, platelayer, knocked down by a pilot engine, his attention at the time being directed to a departing special train.

Date of Accident.	Name of Railway.	Number of Persons		Number of Passengers carried during the Half-year ending 31st Dec. 1851.	Nature and Cause of Accident, taken from the Reports made to the Railway Department by the Railway Companies.
		Killed.	Injured.		
1851. 12 Aug.	South Eastern ...... Greenwich Branch, *contd.*	...	2	...	The coupling of an engine of a passenger train broke when it was about 380 yards from the Folkestone station, and the train receded down the incline until it reached the Harbour station, when the luggage van at the rear of the train was thrown on to the beach: two passengers slightly injured by the train coming into collision with the station buffers.
15 Aug.	ditto	...	1	...	Henry Seager, porter, thrown down by a rope while shunting trucks, and wheels passed over his leg, injuring it so severely as to render amputation necessary.
29 Aug.	ditto	...	1	...	Thomas Church, servant of contractors, incautiously walking in the Blackheath tunnel, was run over: both legs had to be amputated.
22 Sept.	ditto	...	5	...	Five passengers injured in consequence of a special train from Tunbridge running into a pick-up train at the Penshurst station.
6 Oct.	ditto	1	...	...	John Saunders, porter, fell under the wheels of a train alongside of which he had been running with his hand upon one of the trucks.
21 Oct.	ditto	1	...	...	Thomas Impett, porter, a truck of a coal train got off the line, and the deceased falling, or getting out, was run over and killed.
23 Nov.	ditto	...	1	...	William Llewellyn, under-guard on the North Kent line, passing along the top of a train to shut a carriage door which had flown open, came in contact with a bridge, and received a severe wound on the head.
2 Dec.	ditto	1	...	...	Thomas Sopwith, porter, crushed between buffers while coupling trucks, and so seriously injured that death ensued shortly afterwards.
5 Dec.	ditto	...	1	...	Female passenger attempting to get out of a third-class carriage in motion, fell, and one of the wheels passed over her left arm, injuring it so severely as to require amputation.
14 Dec.	ditto	1	...	...	Labouring man run over while crossing the line at about a mile from the Winchilsea station.
31 Dec.	ditto	1	...	...	Richard Boyce, examiner of carriages, had been riding on the step of a carriage, and in getting off fell under the train and was killed.
31 Dec.	ditto	...	3	...	The tender of a passenger train having caught the points at the Bricklayers' Arms station, was thrown off the rails, and the train running into the station with considerable force, three of the passengers were slightly injured.
10 Dec.	South Staffordshire	1	...	576,357	Henry Jones, passenger, while attempting to get into a carriage after the train had started, was run over and killed.

Date of Accident.	Name of Railway.	Number of Persons Killed.	Number of Persons Injured.	Number of Passengers carried during the Half-year ending 31st Dec. 1851.	Nature and Cause of Accident, taken from the Reports made to the Railway Department by the Railway Companies.
1851.					
10 Dec.	South Wales..........	...	...	272,575	
	South Yorkshire ...	...	...	73,290½	
	Stirling and Dunfermline..........	...	...	24,416	
29 Aug.	Stockton and Darlington	1	...	201,802	Margaret Walker, crossing an occupation road at Newport, was run over and killed.
13 Nov.	Stockton and Hartlepool	...	1	60,292	Woman trespassing, run over, and had her leg crushed.
31 Dec.	ditto	1	...	...	William Leach, servant of Company, run over and killed while attempting to cross in front of a train.
29 Sept.	Taff Vale	1	...	140,997	Morgan Evans, servant of Company, fell from waggon in motion, and was killed.
10 July.	Ulster....................	1	...	295,815	Alice Collins, an old woman on crutches, run over and killed while attempting to cross the line at an occupation crossing.
	Vale of Neath........	...	...	36,968	
	Waterford and Kilkenny..............	...	...	18,012½	
21 Aug.	Waterford and Limerick	1	...	42,134	P. O'Brien, switchman, run over at night, through his own want of caution.
20 Sept.	West Cornwall......	1	...	50,595	Mary Bassett, nine years old, daughter of a breaksman, thrown from a mineral train in which she was riding, contrary to orders, the train having run down the incline, owing to the rope having been cut by some person unknown, and getting off the rails was dashed against the side of a cutting.
	Whitehaven and FurnessJunction	...	...	52,551	
	Whitehaven Junction..................	...	...	84,147	
1 July	York and North Midland	1	...	921,514	John Moor, fireman, standing on the buffer ends of a waggon, uncoupling another waggon, fell, and was run over.
2 July	ditto	1	...	...	Thomas Longton, clinging to the side of a waggon in motion, came in contact with a wall, and falling, was run over.
30 July	ditto	1	...	...	Mark Halliday, platelayer, run over by a train while at work; the ordinary signals had been given, but he did not hear them.
19 Sept.	ditto	1	...	...	John Major, platelayer, standing up in a truck throwing some sleepers out as the train passed a station, lost his balance, and falling out was run over and killed.
30 Sept.	ditto	1	...	...	Trespasser run over while asleep on the line.
3 Oct.	ditto	1	...	...	Thomas Gowland, guard of a coke train, killed in consequence of his train being run into by a goods train at the Burton Salmon station.
24 Dec.	ditto	1	...	...	John Nicholson, driving an ass and cart through the open gates at a level crossing, turned along the line, and was run over and killed by a train.

Date of Accident.	Name of Railway.	Number of Persons		Number of Passengers carried during the Half-year ending 31st Dec. 1851.	Nature and Cause of Accident, taken from the Reports made to the Railway Department by the Railway Companies.
		Killed.	Injured.		
1851. 8 Sept.	York, Newcastle, and Berwick......	...	1	1,865,695	Mr. Currie, a passenger, injured by the train running into an engine which was standing on the line near Gateshead.
6 Oct.	ditto	...	1	...	Passenger injured by jumping from an excursion train while it was passing the Pelaw station.
26 Oct.	ditto	...	1	...	Female passenger jumped from the carriage before the train had stopped at the Gateshead station, and, falling, was dragged by the footboard of carriages for some yards; legs severely bruised.
6 Nov.	ditto	1	...	...	Ralph Brown, employed by Electric Telegraph Company, run over by a train and killed. It is supposed he became alarmed and confused on seeing two trains approaching him from opposite directions.
17 Nov.	ditto	...	1	...	Trespasser struck by a train while on the line in a state of intoxication. Arm broken and skull fractured.
22 Dec.	ditto	1	3	...	Patrick Morton, servant of Electric Telegraph Company, killed; three drovers injured. They were riding in guards' van and carriage of cattle train, and while the train was slowly ascending an incline, it was overtaken and run into by a passenger train; weather foggy, and the rails slippery at the time.
22 Dec.	ditto	1	...	...	William Hobson, post messenger, run over and killed while incautiously crossing the line at the Ferryhill station.
	TOTAL	113	264	47,509,392	

SUMMARY.

8 Passengers killed, and	213 injured, from causes beyond their own control.
9 Passengers killed, and	14 injured, owing to their own misconduct or want of caution.
30 Servants of Companies or of Contractors killed, and	17 injured, from causes beyond their own control.
32 Servants of Companies or of Contractors killed, and	11 injured, owing to their own misconduct or want of caution.
33 Trespassers and other persons, neither Passengers nor Servants of the Company, killed, and...	9 injured, by crossing or walking on the Railway.
Suicide 1	
TOTAL, 113 killed	and 264 injured.

The number of Passengers conveyed during the half-year amounted to 47,509,392

The length of Railway open on the 30th June, 1851, was ... 6698 miles.
The length of Railway open on the 31st December, 1851, was .. 6890 miles.

Increase during the half-year ... ... 192 miles.

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